Quaker Bridge Dam and Reservoir.

Reports of the Chief Engineer of the Aqueduct Commission and the Chief Engineer and Consulting Engineer of the Department of Public Works to the Aqueduct Commissioners.

Concluded from page 119.

DEPARTMENT OF PUBLIC WORKS,
BUREAU OF CHIEF-ENG. OF THE CROTON AQUEDUCT,
NEW YORK, January 18, 1886.

To the Hon. the Aqueduct Commission:

GENTLEMEN:

In response to your resolution of the 13th of January, 1886, below please find a few facts and deductions from my past fifteen years' experience in immediate charge of the distribution of water and ten years' immediate charge of the supply of water of the City of New York.

1st. In the year 1880 the storage reservoirs and lakes in the Croton water-shed were exhausted; all the waters of the lakes and ponds, owned by private parties, were bought and used, and the aqueduct would have carried to the city 500,000 gallons more water if it could have been obtained.

2d. The storage capacity of the double reservoir at Sodom, Putnam County, New York, will be about 8,000,000,000 gallons.

3d. The City of New York to-day requires 50,000,000 (millions) gallons a day additional to give a full supply of water. Yesterday the consumers of water wasted, to keep their service pipes from freezing, 12 million gallons of water more than their normal use.

4th. By the time the aqueduct is completed 10,000,000 gallons per day additional will be required, making a total of 60 million gallons a day to be provided for principally from storage in the Croton basin.

5th. In 1880 there were 209 days during which no water ran over Croton dam: 209 days multiplied by 60 million gallons per day additional water required in an extremely dry year, gives 12,540 million gallons of stored water needed in addition to all the storage now owned by or accessible to the city for use.

6th. Thus in the first dry year after the completion of the aqueduct, and with Sodom reservoir completed, the city would be short, as it is now, of storage water for use when required.

7th. All the reservoirs placed on the map of the Croton basin by the Croton Aqueduct Department, are not practicable, especially as many of them would not fill in any one year.

8th. The total capacity of reservoirs practicable in the Croton water-shed is 50,000 million gallons, including lakes and reservoirs already built. As to the necessity of a dam and storage reservoir on the lower part of the Croton river, I would generally state:

The Croton river has been designated by the Legislature as the source of a further supply of water for the City of New York.

The Aqueduct Commission have decided to build an aqueduct 14 feet in diameter, with a capacity of 325,000,000 gallons per day. The capacity of the present aqueduct is 75,000,000 gallons per day.

It becomes necessary to provide this daily quantity of 400 millions per day from the Croton basin.

A.

CROTON BASIN—338 SQUARE MILES.

YEAR.	Rainfall at Boyd's Corner Reservoir.	Average Amount per Day Running from Croton Dam.	Equal to Inches on Whole Basin.	Percentage of Rainfall.	Days no Water ran over Croton Dam.
	Inches	Gallons.	Inches		
1866..	51.77	440,705,578	27.7	51	50
1867..	40.77	541,318,307	34.5	65	0
1868.	50.33	600,524,194	37.	74	8
1869..	48.36	456,575,841	28.	58	80
1870..	44.61	352,105,181	21.5	48	102
1871..	48.94	352,665,477	21.5	44	37
1872..	40.74	307,208,408	20.	49	34
1873..	43 87	444,236,877	27.5	67	116
1874..	42.37	427,638,305	26.5	63	93
1875..	43.66	425,021,738	26.	59	71
1876..	40.68	384,311,292	24.	58	175
1877..	46.03	346,503,178	21.	45	136
1878..	54.14	462,854,304	28.3	52	54
1879..	46.49	392,271,737	21.5	47	92
1880..	38.52	243,300,000	15.	39	207
1881..	46.33	320,900,000	19.7	42	169
1882	55.20	446,918,679	24.8	45	70
1883..	43.15	255,400,000	15.54	36	161
1884..	53 71	407,303,000	25.06	47	100
1885..	45.99	314,320,000	19.50	42	132

The present available Croton river water-shed of 338 square miles has, during the past nineteen years, furnished at Croton dam an average of 396 million gallons per day with an average rainfall of 47 inches; but during the years 1879, 1880 and 1881 there was an average of only 306 millions per day, and an average rainfall of 44 inches; so that the first immediate necessity is to increase the area of water-shed available by building a dam lower on the river. The area of the water-shed can be increased to 362 square miles, and the average rainfall on this increased area of 24 square miles, at the lower end of the basin, is nearly 60 inches a year. See statements A. B. C.

From my knowledge of the Croton river during very dry seasons, and especially of the amount of storage necessary to preserve a large average daily flow, I deem it necessary not only to increase the area of the water-shed, but also to build a large storage reservoir at the lower part of the river, so as to secure all the water during freshets; and in order to average the quantities available during years of least and years of greatest rainfalls, that, as the increased amount of water becomes necessary from the growth of the city, all the storage reservoirs practicable, be built in the upper part of the water-shed as contemplated originally.

In a sanitary view, I have no doubt that all trouble can be obviated as to the character and quality of the water, except what is naturally inherent in all river water.

In view of the powers of the State Board of Health as to sewerage, as expressed in Chapter 513, Laws of 1885, I will quote Edward H. Tracy, formerly Chief Engineer of the Croton Aqueduct: "The best thing the City of New York could do, would be to buy the whole of the Croton Water Shed."

Respectfully submitted,
G. W. BIRDSALL,
Chief Engineer Croton Aqueduct

B.

FOR 400 MILLION GALLONS PER DAY.

Storage required for the 300 Million Gallons of the above not now furnished, as shown by the years.

1879.		1880.		1881.	
Days, and Amount per Day.	Gallons.	Days, and Amount per Day.	Gallons.	Days, and Amount per Day.	Gallons.
92 x 300 M	27,600,000,000	207 x 300 M	62,100,000,000	169 x 300 M	50,700,000,000
17 x 287 M	4,879,000,000	8 x 287 M	2,296,000,000	6 x 287 M	1,722,000,000
18 x 263 M	4,734,000,000	6 x 263 M	1,578,000,000	14 x 264 M	3,682,000,000
22 x 232 M	5,104,000,000	7 x 232 M	1,624,000,000	17 x 232 M	3,944,000,000
28 x 195 M	5,460,000,000	6 x 195 M	1,170,000,000	33 x 195 M	6,435,000,000
39 x 151 M	5,889,000,000	5 x 157 M	755,000,000	15 x 151 M	2,265,000,000
18 x 105 M	1,890,000,000	8 x 105 M	840,000,000	16 x 185 M	1,680,000,000
24 x 55 M	1,320,000,000	180 x 55 M	990,000,000	18 x 555 M	990,000,000
Totals.....	56,876,000,000		71,253,000,000		71,418,000,000

This increased amount can only be obtained:
1st. By increased water-shed at lower part of the river.

	GALLONS.
24 square miles equal to per day 13 million gallons x 365	4,750,000,000
From storage of same by dam at lower part of river	4,750,000,000
2nd. From large storage reservoir, lower part of river	25,000,000,000
3d. From storage reservoirs on upper water-shed	35,500,000,000
Total storage	70,000,000,000

C.

STORAGE RESERVOIRS, CROTON WATER-SHED, "AVAILABLE."

	River.	Name or Letter.	Height of Dam.	Length of Dam.	Estimated Capacity, Gallons.	Drainage Areas, Miles.
Now in use.	Muscoot River.	Lakes Kirk and Mahopac	.....	.....	1,100,000,000	20.45 / 5.40
	do.	A	75	1,215	5,200,000,000	20.46
Making a total for Muscoot river, 6,300,000,000 gallons—300,000,000 gallons per square mile per year.						
Now in use.	West Branch	Boyd's Corners Res	.....	.....	2,700,000,000	20.00
	do.	D	60	1,650	9,000,000,000	41.95
Now in use.	do.	Lake Gleneida	.....	.....	180,000,000	1.
Now in use.	do.	Barrett Pond	.....	.....	180,000,000	1¼
Now in use.	Middle Branch	Lake Gilead	.....	.....	200,000,000	1¼
Now in use.	do.	South E. Reservoir	.....	.....	4,000,000,000	21.
	do.	L	85	850	2,300,000,000	26.86
	Croton River below junction of West and Middle Branch	K	83	1,075	5,700,000,000	78.96
	Making total for	West and Middle Branches	.....	.....	24,260,000,000	
Equal to 310,000,000 gallons per square mile per year.						
	East Branch	I	72	1,075	4,200,000,000	70.52
	do.	H	48	625	2,500,000,000	75.46
	do.	J	80	1,275	2,300,000,000	11.19
	Making total for East Branch		.....	.....	9,000,000,000	
Equal to 120,000,000 gallons per square mile per year.						
	Titicus river	M	72	980	4,400,000,000	23.33
	Cross River	N	71	775	1,700,000,000	30.96
	Beaver Dam Brook	O	93	1,280	2,360,000,000	17.32
	Totals—Gallons of	storage water.	.....	.....	47,860,000,000	244.50

Equal to 191,000,000 gallons per square mile per year, or for 345,000,000 gallons per year per square mile, the storage of 131 square miles, or for driest year, 265,000,000 gallons per square mile per year, the storage on 180 square miles.

DEPARTMENT OF PUBLIC WORKS,
JANUARY 18, 1886.

To the Honorable the Aqueduct Commission:

GENTLEMEN:

Having had an opportunity of hearing the various arguments in opposition to the construction of the Quaker bridge dam, presented by such of the public as interested in the subject, I would respectfully state, that in view of the almost exhaustive character of the reports in the past from this Department, of the circumstances which call for the construction of this dam and reservoir—a review, or criticism, on the nature and bearing of the salient points of the opposition testimony—a rebuttal, in fact, would be the most satisfactory method of arriving at the facts in the case; as, in truth, it is not apparent what, if any, new light has been shed upon this much misunderstood matter within the last two years; but as the resolution of your Board, of date 13th inst., is specific, and calls for "views and reasons why the Quaker Bridge Dam and Reservoir should be constructed," it becomes my duty to comply in accordance therewith.

While the act of the Legislature of June, 1883, creating this Commission, does not necessarily restrict the water supply of the City of New York to what may be gathered from the Croton basin, yet it limits the operations of the Commission to such additional supply as may be had from that basin.

When the scheme of this extension was under advisement in 1881, the then Chief Engineer, Mr. Newton, called several engineers as counsel, to aid him in forming an intelligent opinion upon this subject. Among them were John B. Jervis, E. S. Chesbrough and James B. Francis—three men of ripe experience

Market Report of Engineering Materials.

New York, February 18, 1886.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.			
Angles	1.95c	@	2.00c
" steel	2.35	@	2.45
Tees	2.25	@	2.35
Beams and channels, American	3.0	@	
Tank	1.95	@	2.1
Shell	2.4	@	2.5
Steel plates, Tank	2.5	@	
WROUGHT-IRON PIPE., PITTSBURGH.			
Butt welded, black ..Discount	42½	@	45
" " galvanized "	32½	@	35
Lap welded black "	60	@	62½
" " galvanized "	42½	@	45
Boiler tubes "	55		
RAILS.			
Steel (large lots at mill)	$34.00		
Old rails	21.50	@	22.25
Old rails, steel	22.00	@	23.00
R R. spikes	2.40c.		
R R. splice-plates	2.00		
R R. track bolts, square nuts	3.00		
Barb-wire fencing, galvanized			5.00
" " painted	4.00		
Corrugated iron			
Nails			
Iron, per keg	2.40	@	2.50
Steel do.	2.60	@	27.5

METALS.

COPPER.			
Lake Superior	$11.35	@	11.60
Other Brands	10.25	@	10.45
LEAD.			
Com. Domestic	4.65		4.70
Lead Pipe	.06¼c.		
Tin-Lined Lead Pipe	.15		
Sheet Lead	.07¼		
ZINC.			
Sheet	$5.10	@	5.20

BRICK.

Cargoes (afloat)			
Haverstraw per M.	$9.00		
Fishkill			
Up-River			
Jerseys			
Long Island	8.50		
" Pale	4.00		
FRONTS.			
Croton, red	11.00	@	14.00
" dark	11.00	@	14.00
" brown	10.00	@	13.00
Philadelphia pressed	24.00	@	25.00
Trenton "	24.00	@	25.00
Baltimore "	37.00	@	41.00
Buff "	33.00	@	35.00
Enameled English	65.00	@	130.00
" American	85.00	@	120.00
Fire brick	24.50	@	55.00

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

Alsen's Portland Cement Works	$2.50	@	$3.00
BAETJER & MEYERSTEIN:			
Hanover Portland	2.60	@	2.65
BELLONI & Co.:			
Hemmoor "Crown" brand			2.50
JAMES BRAND:			
K. B. & S	2.55	@	3.00
BROOKS, SHOOBRIDGE & Co.,	2.45	@	2.60
HOWARD FLEMING:			
Gibbs' English Portland, 400 lbs	2.65	@	2.90
K. B. & S. " "	2.75	@	2.95
Stettiner, German	2.65	@	2.85
Lagerdorfer, "	2.45	@	2.75
Fleve, A 1, Belgian	2.35	@	2.50
Roman	2.75	@	3.00
Keene's Coarse	4.75	@	5.50
" Fine	7.75	@	8.50
" Superfine	8.50	@	10.00
FISHER, ERSKINE W.:			
Stettin (German) Portland Cement	$2.40	@	2.75
GABRIEL & SCHALL:			
Vorwohler "Lion"	2.65	@	3.10
HUDSON RIVER CEMENT Co. Rosendale			1. 0
JOHNSON & WILSON:			
Saylor's American Portland	2.15	@	2.40
LESLEY & TRINKLE, Philadelphia, Pa.:			
"Giant" Portland	2.20	@	2.40
Improved "Union"	1.25	@	1.50
Union	1.10	@	1.20
MARCIAL & Co.:			
J. B. White & Bros. Coarse	4.50	@	5.00
" Fine	8.00	@	10.00
" Portland	2.45	@	2.85
NEW YORK CEMENT Co.:			
Rosendale			1.20
N. Y. & ROSENDALE CEMENT Co.:			
Rosendale, "Bridge" brand			1.10
SINCLAIR & BABSON:			
K. B. & S	2.35	@	2.60
STANDARD CEMENT Co.			
E. THIELE:			
Dyckerhoff	2.90	@	3.25
UNITED STATES CEMENT Co.:			
Windsor	1.00	@	1.10
Standard			1.15
Cold's Portland	2.15	@	2.40
UNION AKRON CEMENT Co.:			
Akron "Star" brand.			

ASPHALT.

Prices range per ton	$15.00	@	20.00
According to quantity or brand, and whether taken from vessel or store.			

LIME.

Rockland, common per bbl	1.00		
" finishing	1.20		
State, common	.90		
" finishing	1.10		
Kingston, ground	95	@	1.00
Add 25c. to above figures for yard rates.			

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@	1.00
" " No. 2 "	0.75	@	0.85
" " light drab "	0.80	@	0.95
Berlin " in rough "	0.75	@	1.00
Berea " "			
Brown stone, Portland, Ct. "	1.00	@	1.35
" Belleville, N. J. "	1.00	@	1.35
Granite, rough	0.45	@	1.25
Common building stone per load	2.00	@	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@	3.00

SLATE.

Purple roofing per square	6.00	@	7.00
Green "	6.00	@	7.00
Red "	15.00		
Black Penna. (at New York) "	4.50	@	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@	20.00
" Choice "	65.00	@	70.00
Tally plank, 1¼ in. 10 in. dres'd, each.	.44	@	.50
Tally boards, dressed com. "	.28	@	.30
SPRUCE, Boards dressed "	.25	@	.28
Plank, 1¼ in "	.28	@	.30
" 2 in. "	.38	@	.40
" 2 in. dressed "	.43	@	.45
Timber per M.	20.00	@	22.00
HEMLOCK, Boards each.	.18	@	.20
Joist, 2½ × 4 to 4 × 6 in	.16	@	.44
OAK per M.	55.00	@	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00	@	40.00
YELLOW PINE, Girders "	25.00	@	30.00
Dressed flooring "	28.00	@	35.00
SHINGLES, Extra shaved pine, 16in. "			
" sawed 18 in. "	5.75	@	6.00
LATH, Cargo rate "	2.30	@	2.35

PAINT.

Lead, white, American dry per lb	.04½	@	.06
" " " in oil pure "	.06½		
" English, B. B. in oil "	.08½	@	.08¾
" Red, American "	.05½	@	.05½
Litharge "	.05	@	05½
Venetian red, American "	.01	@	.01¼
Indian red "	.05	@	.10
Vermillion, American lead "	.10½	@	.12½
Paris green "	.15	@	.20
Umber, Amer. raw and powdered per lb.	.01¼	@	.01¾
Drop black, Amer.	.07	@	.13
" " Eng	.11	@	.13
Chrome green	.05	@	20
Oxide zinc, American	.03¾	@	.04
" French	.06	@	.08

Trade Notes.

THE Cambria Iron Co., at Johnstown, Pa., has received an order from the Chicago, Burlington and Quincy Railroad for 1,500 tons of steel rails; and the Pennsylvania Steel Company has booked an order for 10,000 tons for the same road.

THE Marshall (TEX.) Foundry and Wheel Factory have closed a contract with the receivers of the Texas & Pacific Railroad Company to supply the road and its branches with car wheels and all its castings.

THE St. Louis architectural iron works have about exhausted their old, and have very few new, contracts. There are at present only two or three large contracts not worked out.

THE New York Locomotive Works, Rome, are now engaged upon three 10-wheel freight engines for the Rome, Watertown and Ogdensburg R. R.

THE Brooks Locomotive Works, in Dunkirk, N. Y., have taken an order for three locomotives for the new Chautauqua Lake R. R., to be delivered early in the spring; and has received a large order from the Union Pacific R. R.

THE Akron Sewer Pipe Agency of Akron, O., was dissolved recently, and in its place was organized the American Sewer Pipe Co., which will take all the product of the mills, formerly in the agency.

THE President and Directors of the Sheffield Land Co., at a meeting in Montgomery, Ala., arranged to have an iron furnace of the capacity of 150 tons built at Sheffield.

THE Columbia Iron Company, with a capital stock of $50,000, has been chartered at the Pennsylvania State Department. Work has been commenced on the new mill site. The contract calls for the mill's completion in thirty days.

THE Knoxville Car Wheel and Machine Company has received an order from the Savannah, Florida and Western Railroad for 4,200 wheels on axles to be delivered the first of May, when they change to standard gauge. The machine department of these works is so crowded that they will be compelled to run night and day for the next four months.

OTTAWA, Feb. 9.—The prospects for this year's lumber trade in the Ottawa district are reported better than for many years past. The cut this year will be unusually large, the output being estimated at 600,000,000 feet. Sales have already been made to the value of $4,500 000, and the prices obtained are better than previously recorded.

BUFFALO, N. Y., Feb. 9.—The plans for the enlargement of the West Shore shops at East Buffalo to suit the requirements of the New York Central Sleeping Car Company have been received here. The shops will be enlarged so that 80 cars can be handled at one time. The changes are estimated to cost $200,000. All of the cars of the company will be built here, as well as the making of all repairs. It is expected that 600 men will be kept busy when the shops are finished.

NEW YORK, February 6.—A Montreal special says: It is learned that Canadian buyers have taken heavy deals in the Glasgow pig iron market, attracted there by the unusually low prices. Over 50,000 tons have been bought by strong parties who believe prices cannot go lower. The purchase was made at about 40s, and after it was closed prices ran up to 40s 2d. A large dealer here says there are many Montrealers as well as Western foundry men in the deal, and that a combination is being formed to "bull" the market.

PHILADELPHIA, PA., Feb. 7.—There are orders with the different steel rail manufacturers of the country estimated at 60,000 tons. The number would in all probability be 170,000 tons, if the manufacturers were disposed to accept payment for their product in bonds and stock of projected lines. As this class of security is in the hands of financial agents in the leading business centers, they will undoubtedly be placed, and the orders for steel rails will eventually be placed for cash to a better advantage, both to purchaser and manufacturer. The Bessemer manufacturers, at a meeting just held here, have decided not to increase the output from 1,000,000 tons to some higher figure, but to meet again and consider the subject when the requirements of the market make it necessary.

IN the case of the Chicago Tire and Spring Works against the Collector of Customs at Chicago the Supreme Court has decided that the Inspector of Customs had properly classified steel tire blooms under Schedule E, Section 2,504, which requires a duty of 45 per centum ad valorem on all manufactures of steel or of which steel is a component part, and on all articles of steel partially manufactured. The plaintiffs insisted that they should have been classed under another paragraph as "steel in any form not otherwise provided for, 30 per centum ad valorem."

THE annual exports from Queensland are now about $18,000,000, mostly wool, preserved meats and tallow; South Australia, $27,000,000, mostly wool, wheat, flour and copper; Tasmania, $4,000,000 mostly wool, grain and fruits; Victoria, $80,000,000, mostly wool, grain, gold and flour; West Australia, $3,000,000, almost entirely wool and lead ore. In the five provinces there are 4,312 miles of railroads and 17,743 miles of telegraph lines. Instead of the short lines along the coast, the railroads now cover long distances, as the great areas are being opened up. Western Australia alone is 1,280 miles long and 800 miles wide, but the inhabited part of the province is only 600 by 150 miles in length and breadth.

THE copper production for the last decade is as follows in long tons:

Years.	Long tons.	Years.	Long tons.
1876	19,000	1881	32,000
1877	21,000	1882	40,467
1878	21,500	1883	51,574
1879	23,000	1884	63,555
1880	27,000	1885	70,109

Of the 70,109 tons produced last year, the Lake Superior region is credited with 31,763; Montana, 26,560; Arizona, 10,268; other states and territories, 1,518. The exports were 34,375 tons; consumption 42,165; stocks December 31st, 4,464.

A GENERAL survey of our foreign markets reveals some points of interest. Chili gives signs of improvement. In Peru there is restored confidence. In the Argentine Confederation trade is dormant, and in consequence of a deranged currency is the worst known for years. English and German houses suffer in common with all others. Australia is slowly recovering from bad seasons experienced by agriculturists, low prices for sugar, etc. New Zealand remains depressed. Throughout the East, in China, Japan and Oceanica, in the Dutch and British East Indies, the depression is extraordinary, and there are no signs of recovery. Among European countries the situation in France is perhaps the most discouraging.

THERE is considerable difference between the workmen and operators as to the cost of coke. The former claim that it costs but about $1 a ton to put coke on the cars; the operators that $1.15 is nearer the mark. The following are for actual workings for the month of November.

	No. 1.	No. 2.
Average cost of coal to ton of coke, including royalty	76.7	81.8
Average labor at ovens	27.0	32.8
Average supplies	7.3	7.0
Average repairs	6.2	2.9
	117.2	124.5

The above are actual costs, not estimates, and may be taken to fairly represent the average, not the best located works. The items of repairs may vary somewhat, as well as the cost of coal; but the No. 1 is a fair cost, including royalty. The miners' figures of cost are as follows. They represent the daily expenses of a bank of 40 ovens, 20 being drawn each day:

Cost of coal (on royalty ½c per bushel)	$12.35
70 cars of coal (mining 27c a car)	18.90
Boss' wages	2.00
Oil, posts, rails, etc	1.50
Charging ovens	2.00
Leveling	1.60
Drawing 20 ovens	11.00
Interest on capital	2.50
Syndicate's commission	3.65
	$58.15
Production 58 8-10 tons coke, at $1.20	$70.56
Less daily expense	58.15
	$12.41

Quaker Bridge Dam and Reservoir.

Reports of the Chief Engineer of the Aqueduct Commission and the Chief Engineer and Consulting Engineer of the Department of Public Works to the Aqueduct Commissioners.

Concluded from page 119.

DEPARTMENT OF PUBLIC WORKS,
BUREAU OF CHIEF-ENG. OF THE CROTON AQUEDUCT.
NEW YORK, January 18, 1886.

To the Hon. the Aqueduct Commission:

GENTLEMEN:

In response to your resolution of the 13th of January, 1886, below please find a few facts and deductions from my past fifteen years' experience in immediate charge of the distribution of water and ten years' immediate charge of the supply of water of the City of New York.

1st. In the year 1880 the storage reservoirs and lakes in the Croton water-shed were exhausted; all the waters of the lakes and ponds, owned by private parties, were bought and used, and the aqueduct would have carried to the city 500,000 gallons more water if it could have been obtained.

2d. The storage capacity of the double reservoir at Sodom, Putnam County, New York, will be about 8,000,000,000 gallons.

3d. The City of New York to-day requires 50,000,000 (millions) gallons a day additional to give a full supply of water. Yesterday the consumers of water wasted, to keep their service pipes from freezing, 12 million gallons of water more than their normal use.

4th. By the time the aqueduct is completed 10,000,000 gallons per day additional will be required, making a total of 60 million gallons a day to be provided for principally from storage in the Croton basin.

5th. In 1880 there were 203 days during which no water ran over Croton dam; 209 days multiplied by 60 million gallons per day additional water required in an extremely dry year, gives 12,540 million gallons of stored water needed in addition to all the storage now owned by or accessible to the city for use.

6th. Thus in the first dry year after the completion of the aqueduct, and with Sodom reservoir completed, the city would be short, as it is now, of storage water for use when required.

7th. All the reservoirs placed on the map of the Croton basin by the Croton Aqueduct Department, are not practicable, especially as many of them would not fill in any one year.

8th. The total capacity of reservoirs practicable in the Croton water-shed is 50,000 million gallons, including lakes and reservoirs already built. As to the necessity of a dam and storage reservoir on the lower part of the Croton river, I would generally state:

The Croton river has been designated by the Legislature as the source of a further supply of water for the City of New York.

The Aqueduct Commission have decided to build an aqueduct 14 feet in diameter, with a capacity of 325,000,000 gallons per day. The capacity of the present aqueduct is 75,000,000 gallons per day.

It becomes necessary to provide this daily quantity of 400 millions per day from the Croton basin.

A.

CROTON BASIN—338 SQUARE MILES.

YEAR.	Rainfall at Boyd's Corner Reservoir.	Average Amount per Day Running from Croton Dam.	Equal to Inches on Whole Basin.	Percentage of Rainfall.	Days no Water ran over Croton Dam.
	Inches	Gallons.	Inches		
1866..	51.77	440,705,538	27.7	51	50
1867..	50.77	541,318,307	34.5	65	0
1868.	50.33	600,524,194	37.	74	8
1869..	48.36	456,575,841	28.	58	80
1870..	44.63	352,505,181	21.5	48	102
1871..	48.94	352,605,477	21.5	44	37
1872..	40.74	307,208,408	20.	49	31
1874..	43 87	444,236,877	27.5	67	116
1874..	42.37	427,648,305	26.5	63	93
1875..	43.66	425,021,738	26.	59	71
1876..	40.68	384,311,292	24.	58	175
1877..	46.03	346,503,178	21.	45	136
1878..	54.14	462,854,304	28.3	52	54
1879..	46.08	352,271,737	21.5	47	92
1880..	38.52	243,340,000	15.	39	207
1881..	46.33	320,900,000	19.7	42	169
1882	55.20	405,918,679	24.8	45	70
1883..	43.15	255,400,000	15.54	36	161
1884..	53.71	407,303,000	25.05	47	109
1885..	45.99	314,320,000	19.50	42	132

The present available Croton river water-shed of 338 square miles has, during the past nineteen years, furnished at Croton dam an average of 396 million gallons per day with an average rainfall of 47 inches; but during the years 1879, 1880 and 1881 there was an average of only 306 millions per day, and an average rainfall of 44 inches; so that the first immediate necessity is to increase the area of water-shed available by building a dam lower on the river. The area of the water-shed can be increased to 362 square miles, and the average rainfall on this increased area of 24 square miles, at the lower end of the basin, is nearly 60 inches a year. See statements A. B. C.

From my knowledge of the Croton river during very dry seasons, and especially of the amount of storage necessary to preserve a large average daily flow, I deem it necessary not only to increase the area of the water-shed, but also to build a large storage reservoir at the lower part of the river, so as to secure all the water during freshets; and in order to average the quantities available during years of least and years of greatest rainfalls, that, as the increased amount of water becomes necessary from the growth of the city, all the storage reservoirs practicable, be built in the upper part of the water-shed as contemplated originally.

In a sanitary view, I have no doubt that all trouble can be obviated as to the character and quality of the water, except what is naturally inherent in all river water.

In view of the powers of the State Board of Health as to sewerage, as expressed in Chapter 513, Laws of 1885, I will quote Edward H. Tracy, formerly Chief Engineer of the Croton Aqueduct: "The best thing the City of New York could do, would be to buy the whole of the Croton Water Shed."

Respectfully submitted,
G. W. BIRDSALL,
Chief Engineer Croton Aqueduct

B.

FOR 400 MILLION GALLONS PER DAY.

Storage required for the 300 Million Gallons of the above not now furnished, as shown by the years.

1879.		1880.		1881.	
Days, and Amount per Day.	Gallons.	Days, and Amount per Day.	Gallons.	Days, and Amount per Day.	Gallons.
92 x 300 M	27,600,000,000	207 x 300 M	62,100,000,000	169 x 300 M	50,700,000,000
17 x 287 M	4,879,000,000	8 x 287 M	2,296,000,000	6 x 287 M	1,722,000,000
18 x 263 M	4,734,000,000	6 x 263 M	1,578,000,000	14 x 264 M	3,682,000,000
22 x 232 M	5,104,000,000	7 x 232 M	1,624,000,000	17 x 232 M	3,944,000,000
28 x 195 M	5,460,000,000	6 x 195 M	1,170,000,000	33 x 195 M	6,435,000,000
39 x 151 M	5,889,000,000	5 x 157 M	755,000,000	15 x 151 M	2,265,000,000
18 x 105 M	1,890,000,000	8 x 105 M	340,000,000	16 x 185 M	1,680,000,000
24 x 55 M	1,320,000,000	18 x 55 M	990,000,000	18 x 555 M	990,000,000
Totals.....	56,876,000,000		71,253,000,000		71,418,000,000

This increased amount can only be obtained:
1st. By increased water-shed at lower part of the river.

	GALLONS.
24 square miles equal to per day 13 million gallons x 365	4,750,000,000
From storage of same by dam at lower part of river	4,750,000,000
2nd. From large storage reservoir, lower part of river	25,000,000,000
3d. From storage reservoirs on upper water-shed	35,500,000,000
Total storage	70,000,000,000

C.

STORAGE RESERVOIRS, CROTON WATER-SHED, "AVAILABLE."

	River.	Name or Letter.	Height of Dam.	Length of Dam.	Estimated Capacity, Gallons.	Drainage, Areas, Miles.
Now in use.	Muscoot River.	Lakes Kirk and Mahopac	.....	.....	1,100,000,000	20.45 / 5.40
	do.	A	75	1,215	5,200,000,000	20.45
Making a total for Muscoot river, 6,300,000,000 gallons—300,000,000 gallons per square mile per year.						
Now in use.	West Branch	Boyd's Corners Res	.....	.....	2,700,000,000	20.00
	do.	D	60	1,650	9,000,000,000	41.98
Now in use.	do.	Lake Gleneida	.....	.....	180,000,000	1.
Now in use.	do.	Barrett Pond	.....	.....	180,000,000	1¼
Now in use.	Middle Branch	Lake Gilead	.....	.....	200,000,000	1¼
Now in use.	do.	South E. Reservoir	.....	.....	4,000,000,000	21.
	do.	L	85	850	2,300,000,000	26.86
	Croton River below junction of West and Middle Branch	K	83	1,075	5,700,000,000	78.96
	Making total for	West and Middle Bran	ches	.....	24,260,000,000	
Equal to 310,000,000 gallons per square mile per year.						
	East Branch	I	72	1,075	4,200,000,000	70.52
	do.	H	48	625	2,500,000,000	75.46
	do.	J	80	1,275	2,300,000,000	11.19
	Making total for E	ast Branch	.....	.....	9,000,000,000	
Equal to 120,000,000 gallons per square mile per year.						
	Titicus river	M	72	960	4,400,000,000	23.33
	Cross River	N	71	775	1,700,000,000	30.96
	Beaver Dam Brook	O	93	1,280	2,200,000,000	17.32
	Totals—Gallons of	storage water	.....	.....	47,860,000,000	244.50

Equal to 193,000,000 gallons per square mile per year, or for 345,000,000 gallons per year per square mile, the storage of 131 square miles, or for driest year, 265,000,000 gallons per square mile per year, the storage on 180 square miles.

DEPARTMENT OF PUBLIC WORKS,
JANUARY 18, 1886.

To the Honorable the Aqueduct Commission:

GENTLEMEN:

Having had an opportunity of hearing the various arguments in opposition to the construction of the Quaker bridge dam, presented by such of the public as interested in the subject, I would respectfully state, that in view of the almost exhaustive character of the reports in the past from this Department, of the circumstances which call for the construction of this dam and reservoir—a review, or criticism, on the nature and bearing of the salient points of the opposition testimony—a rebuttal, in fact, would be the most satisfactory method of arriving at the facts in the case; as, in truth, it is not apparent what, if any, new light has been shed upon this much misunderstood matter within the last two years; but as the resolution of your Board, of date 13th inst., is specific, and calls for "views and reasons why the Quaker Bridge Dam and Reservoir should be constructed," it becomes my duty to comply in accordance therewith.

While the act of the Legislature of June, 1883, creating this Commission, does not necessarily restrict the water supply of the City of New York to what may be gathered from the Croton basin, yet it limits the operations of the Commission to such additional supply as may be had from that basin.

When the scheme of this extension was under advisement in 1881, the then Chief Engineer, Mr. Newton, called several engineers as counsel, to aid him in forming an intelligent opinion upon this subject. Among them were John B. Jervis, E. S. Chesbrough and James B. Francis—three men of ripe experience

and of acknowledged national reputation as hydraulic engineers. The entire question of city supply came up, and all possible sources were discussed, and in the several reports made by the above named, their opinions were recorded in favor of the Croton basin as the source of supply—not that the supply thence might not ultimately prove inadequate to the wants of the city—but, that for reasons stated, the yield from this basin should first be exhausted before looking elsewhere, and in the presumed necessity for utilizing the flow from this basin to the *utmost extent possible*, the impounding of the water, at the *lowest* available point of the water-shed, became a matter of the first importance. In fact, unless the basin can be dammed near its outlet, the maximum of flow from it for economic uses cannot be had. This principle is too well recognized to call for any argument. The statement of Mr. Newton, under a resolution of the Mayor's Commission on water supply, of date February 21, 1883, calling for information relative to storage, gives an illustration of this principle as applied to the Croton basin, when he shows (on page 11), "that the additional area gained by placing the dam as proposed near the mouth of the Croton, at the end of the water-shed, is 115.39 square miles out of a total shed of 361.82 square miles." It would seem that this evidence, failing any question of its accuracy, should suffice for upholding the construction of the Quaker bridge dam and reservoir, as proposed.

The Chief Engineer of this Department, in response to the resolution of the 13th inst., gives the results of experience derived from nearly a score of years devoted exclusively to the practical details connected with the water supply from the Croton shed, and its distribution in the city, with its bearing on the question of a dam near the outlet of the Croton, with all needed detail. I might properly confine myself to a concurrence in the conclusions which he has reached; but, in addition, I trust that a brief statement of some general principles applicable to this case will not be considered as irrevelant.

Had the distribution of the rain-fall in 1881 been different, a contingency within the range of probability, the total yearly fall and average daily flow remaining the same as in 1880, yet the length of drought might have been sensibly increased, and with it the difficulty of meeting the deficiency by a storage reserve. For instance: the *average daily* flow of the Croton basin in 1880 was 244 million gallons, or 156 milion gallons less than the combined capacity of the Aqueducts, but for 209 days of that year no water passed over the dam, that flow from the basin being less than 100 million of gallons daily, or much less than one-half the estimated daily average for the year; and the deficiency below the capacity of the Aqueducts, for that length of time, would have been in excess of 250 million gallons daily instead of 156 million, while the discrepancy would increase with every additional day during which no water passed over the dam. These meteorological uncertainties must be met, not by a ingenious paper estimate of the interposition of *possible* rain storms, but by a liberal capacity for storing freshet water. In fact, the best possible position which the locality affords is called for.

Notwithstanding the vital importance to modern cities of the water supply, the history of all these works furnish evidence that the principle of *averages*, wherever it has been followed as a guide, is fallacious and misleading, and that any gravity supply based upon it will be liable to failure. The principle now recommended by the most experienced men in England, with a climate certainly no drier then our own, is that a storage capacity of 150 days' use will suffice for localities with large rain-falls, but in drier districts no less than 200 days' use is to be relied upon. Judged by this standard, and considering our rain-fall as medium, we should have storage for 175 days, which, with the requirement of 400 million gallons daily, would be 70,000 million of gallons—a result reached by Chief Engineer Birdsall, by a much more detailed method of computation, in his report of this date.

Such are the principles in brief, which demand the construction of the Quaker Reservoir, viz., it will impound more water in greater body, which is an element of wholesomeness, than will any system of reservoirs which it is possible to construct on the Croton basin in lieu of it.

Other reservoirs will become necessary before the limit of the capacity of the water-shed is reached. These will be of necessity comparatively small, and will come in play from time to time, as the needs of the city may point out as desirable; but if nearly one-half of the total storage required can be had in one reservoir, it is surely the part of wisdom to provide it in bulk, rather than to distribute it in a half dozen shallow tanks; and this, without reference to the relative economy of the two methods. The cost becomes a secondary consideration in comparison with increased efficiency and purity, and as whatever objections have been urged against this reservoir, they all culminate in the alleged impurity of this method of impounding the flow from the Croton basin, I may be pardoned for an additional word or two on this important subject of its purity.

The length of the Quaker reservoir will be some fifteen miles, with varying widths to over half a mile, and depths increasing gradually to 150 feet or thereabouts; the direction of the shore line taking every possible point of the compass, and open to breezes from all directions, receiving daily accessions of water from the shed above, the aqueduct below making daily drafts upon its contents frequently in excess of the influx; with varying currents, never wholly suppressed, under constantly varying atmospheric changes of temperature, and modified by the irregularities of sides and bottom.

That a body of water so circumstanced, should ever become stagnant, is beyond the range of possibility. If it were a natural lake, no one would venture for a moment to anticipate such a result, and, save for a short time when first filled, the conditions will differ in no essential from that of a natural body of water.

The wash into it from its slopes will be no greater, nor differ from what would be the case, were it a natural lake. If the freshet water from the entire basin is to be collected in reservoirs scattered over its surface, as their advocates claim can be anticipated, and which, in truth, is essential to utilizing the maximum flow from the basin, then the wash of objectionable matter from the surface of the drainage area is equally great, whatever method be adopted which secures the entire flow, with the disadvantage in the case of the smaller reservoirs, of depositing the material in shallower receptacles; and when, after accumulating to an objectionable extent, it is flushed out by means of appropriate waste gates, it must pass for settlement into the present Croton Lake, or Muscoot reservoir (if the latter be built), to be drawn, it may be, into the city; whereas, if it be desirable to flush out the lower strata of the Quaker reservoir, by the means provided to that end, it would be swept into the Hudson river. This latter means as a necessity, never will arise probably, though provided for, to quiet apprehension upon that point.

The population on the water-shed gives about eleven acres to each inhabitant, and about 120 acres to each house, and with the refuse from all animal life deposited on, or in the earth, as is customary in the country, Dame Nature has provided a means by which ten times this population would not poison an inhabitant of

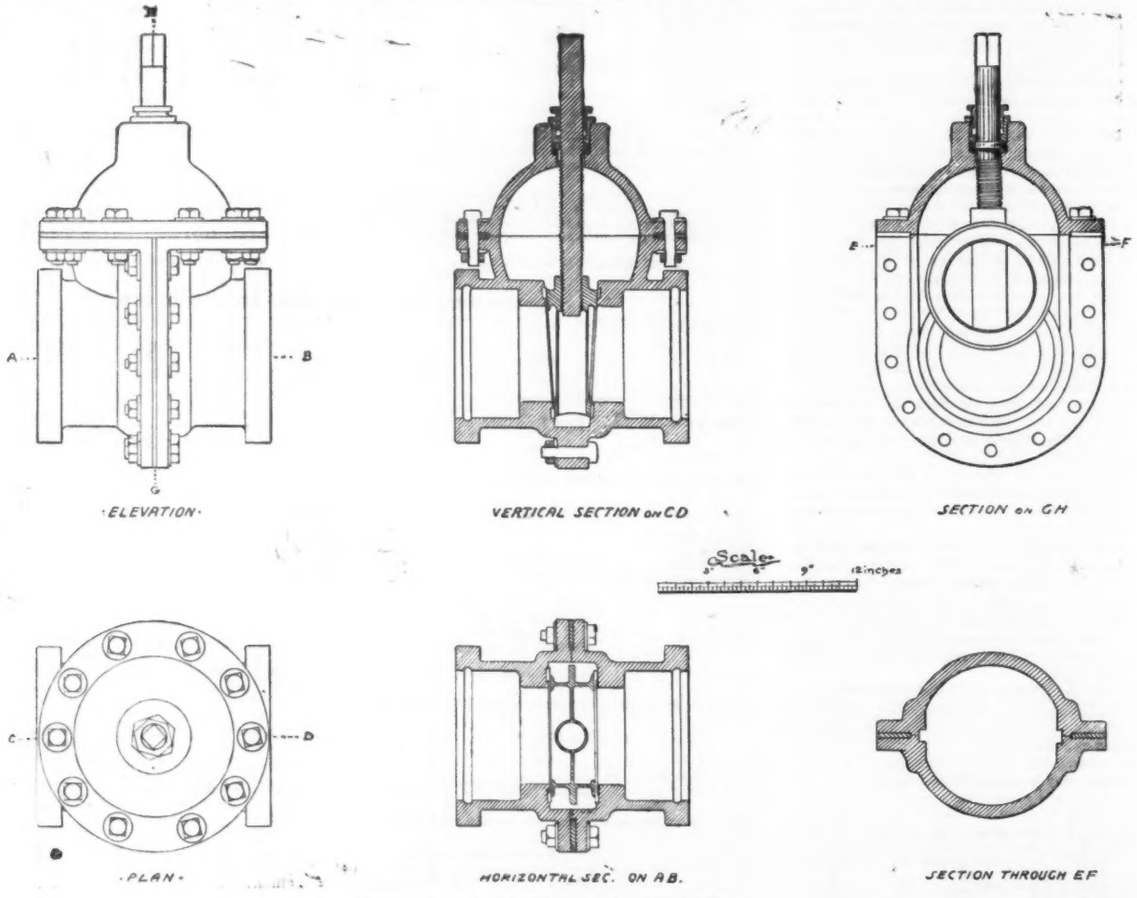

Plate 10.—6 inch Gate. (See Page 114.)

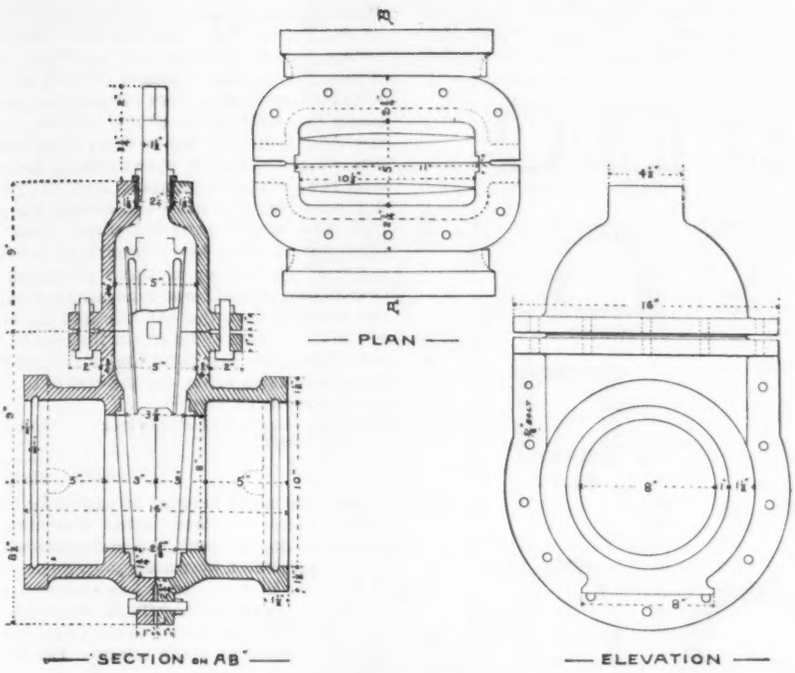

Plate 11—8 inch Boston Gate. (See Page 114.)

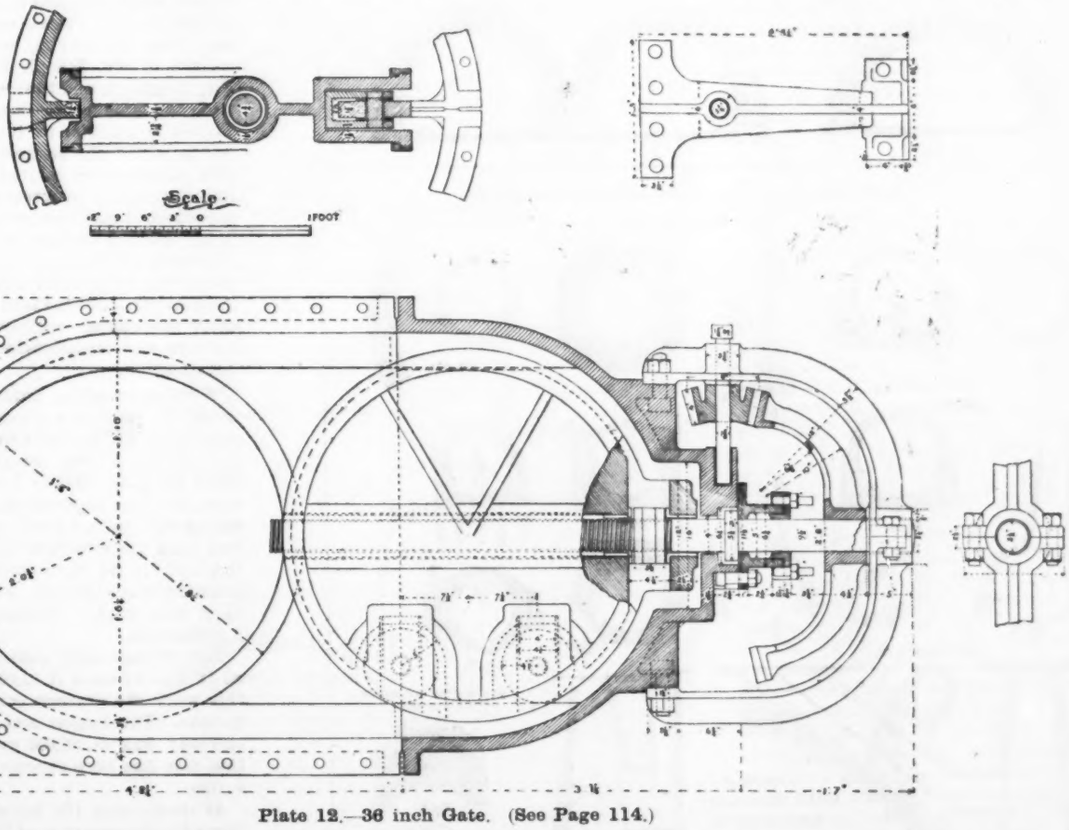

Plate 12.—36 inch Gate. (See Page 114.)

mits of ready treatment in the way of purification by combined irrigation and filtration. We hear now, however, in the progress of science, of "disease germs," which nothing short of some chemical agent will destroy. What, and whence they are, nobody knows, but one thing is certain, if these germs are living organism, as stated, no amount of filth, however concentrated, can of itself suffice to generate them, however well conditioned it may be for their subsequent development. Life can only spring from life. These germs may feed and increase through filthy surroundings, but they cannot be generated by it; and this points to the only sure method of destruction, as clearly within the province of the physician to carry out, under the authority of intelligent health boards.

I have ventured merely to touch upon this subject of proper sanitary methods, and so far as to assure the fearful, that there is no danger to health, now or in the hereafter in the use of impounded Croton water, which an intelligent application of the means at our disposal will not suffice to render harmless.

Respectfully submitted,

JULIUS W. ADAMS,
Consulting Engineer.

Municipal Engineering; Paper No. 1.*

BOSTON, MASSACHUSETTS.

(*Continued from page* 116.)

As showing the condition of the old sewerage system of Boston we introduce here Plate 16 from Mr. Clarke's book; each one of these "common types" is drawn from an actual sewer or drain examined and measured in the course of the surveys for, and construction of the improved sewerage. Very many of these are still in daily service, and of many others there is literally no record, except the knowledge that a sewer of some kind exists in certain streets. Mr. Clarke states that probably one-half of the larger main sewers are built of wood and have flat bottoms.

No steps looking towards an improvement upon this dangerous condition of affairs were taken until about 1870, at which time the average annual death rate was about 25 per 1000.

New York, fifty miles distant. Decaying vegetable matter, though disagreeable, cannot be considered as noxious. Animal excreta *is* a pollution, which, but for the principle of Nature alluded to, would render water, gathered from any occupied land, objectionable. This principle may be thus stated. The substances forming animal excreta are extremely unstable in their chemical composition, and in the presence of oxygen they are constantly tending to change, this change involving a destruction of their noxious properties by their conversion into inert, harmless compounds. This change may be brought about by exposure to the air, or the free oxygen which most waters contain, and were it not so, and in daily operation, the rivers of the world, washing inhabited shores, instead of being of almost universal use as potable water, would long since have been found inimical to public health. So that the scattered inhabitants, together with the animals incident to rural life, have no ill effect whatever upon water draining from the surface into streams of any magnitude. But where dense settlements occur, as of towns, and human excreta, instead of being deposited in the earth, and rendered subject to the action of the above natural law, is collected and discharged by drains and sewers direct into the streams, unless the volume of the latter be very great, the water would be prejudicial to the public health. Therefore, the drainage from sewered towns should by law undergo some efficient purification before being admitted into any stream which is liable to be used for domestic purposes.

The above refers to healthy excreta alone, which al-

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The consulting physicians in the year named addressed the authorities, pointed out the many existing evils and declared the urgent necessity of a better system of drainage. After several ineffectual efforts, the City Council, on March 1, 1875, authorized the Mayor to appoint a commission made up of two civil engineers of experience and one person skilled in sanitary science, who were to examine and report upon the then existing system and present a plan for the future wants of the city.

The Mayor accordingly appointed as members of this commission, E.S.Chesbrough, C.E., Moses Lane, C. E., and C. F. Folsom, M. D., gentlemen of exceptional professional attainments and reputation. The commission at once went to work and practically recommended two main drainage systems, one for each side of the Charles river; the one on the south to have its outlet at Moon Island (see Plate 1), and the one on the north to discharge at Pt. Shirley, both opening into the sea at points remote from the city and from dwellings. The general features of both systems were identical: these were intercepting sewers along the water-front of the city to receive the flow from existing sewers; main sewers into which the former were to empty and conduct the sewage to pumping stations; pumping machinery to raise the sewage about 35 feet, and outfall sewers leading from the pumping stations to reservoirs at the final point of discharge; in these reservoirs the sewage was to be allowed to accumulate during the latter part of the ebb-tide and the whole of the flood, and to be let out into the harbor only during the first two hours of the ebb-tide. The commission estimated the cost of the proposed work as follows;—

Territory south of Charles river....	$3,746,500
" north " " "	2,804,564
Total,	$6,551,064

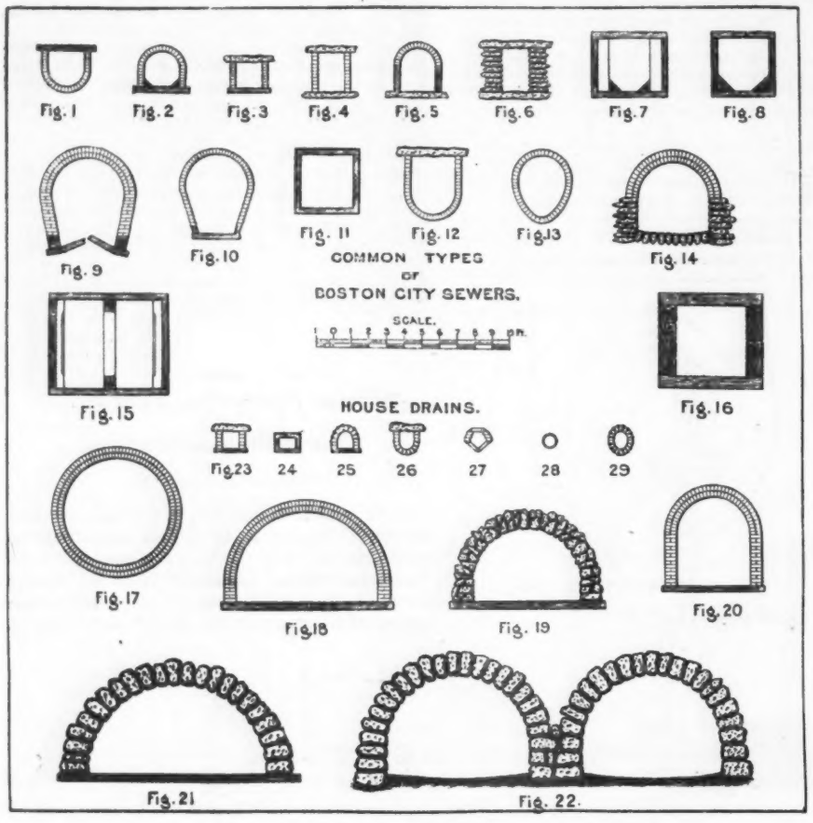


Plate 16.—Common Types of Boston Sewers and Drains.

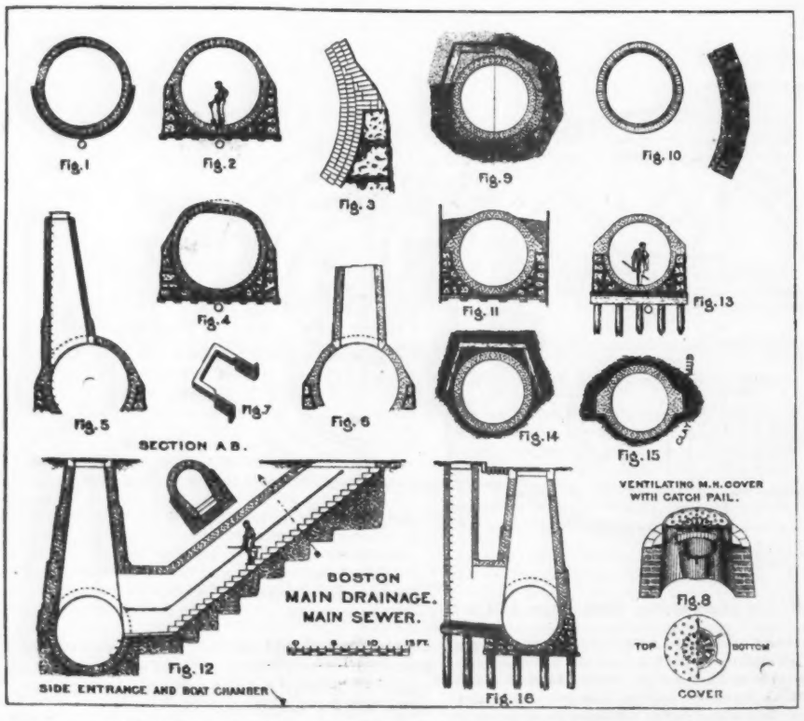


Plate 17.—Types of Modern Boston Sewers. Improved Sewerage System.

After the usual amount of opposition from citizen "experts" and other objectors to municipal improvement, the recommendations of the commission were accepted, and on April 11, 1876, the Massachusetts Legislature passed an Act empowering the city to construct the system lying to the south of the Charles river and discharging at Moon Island. The whole subject was put into the hands of a Joint Special Committee of City Councils on Improved Sewerage, and in July 1876 the first appropriation of $40,000 was made for surveys, etc. The engineering was placed under the charge of Mr. Joseph P. Davis, C. E., then City Engineer, and to this gentleman's ripe experience and professional skill the City of Boston is indebted for the very efficient manner in which the suggestions of the commission of 1875 were carried into execution. As the examination progressed, Mr. Davis found it expedient to make some radical modifications in the original scheme, notable in the manner of crossing Dorchester Bay. The City Engineer was ably seconded in this important work by Mr. Eliot C. Clarke, C. E., who was very early appointed engineer-in-charge of the surveys and investigations and the final total construction.

Without entering into the details of this work, for which we must again refer our readers to Mr. Clarke's book, we will only say that on Jan. 1, 1884, the greater portion of the Main Drainage Works were in such a state of completion as to permit its use for disposing of the sewage from a great part of the city, and it was then put into operation. Since that date the system as then contemplated has been practically completed. The total expenditure upon this work January 1, 1885, has been $ 5,168,456.01.

The average daily quantity of sewage pumped in dry weather is 24,000,000 gallons; to do this work the average consumption of coal is 3¼ tons. The largest amount pumped in any one day was 81,280,000 gallons, though even this rate has been exceeded for a few hours at a time.

As illustrating the latest practice in dealing with the sewerage of Boston, we will make some further extracts from Mr. Clarke's work, coupling with them the results of a personal examination of the improved sewerage system of that city.

In calculating the probable amount of sewage to be dealt with and the consequent size of the sewers in the new system, it was first necessary for the engineers to assume some limit of territory tributary to the intercepting sewers. An area of 58 square miles was taken as indicated by the natural surface; of this area about 46 square miles was land 40 or more feet above low tide, and, as suggested

by the Commission, could be drained by a high-level intercepting sewer if necessary and conveyed by gravity to Moon Island. This left 12 square miles below grade 40 that must forever drain into the low-level system. But as it will be long before the high-level system will become absolutely necessary and built, existing sewers above grade 40 had to be provided for, and consequently 20 square miles were assumed for purposes of calculation, as tributary to the proposed intercepting system.

The prospective population was estimated at 62½ persons per acre, or 800,000 in total, in all calculations effecting the main sewer; but in proportioning the branch intercepting sewers greater densities of population were taken. The amount of sewage per individual was estimated at 75 gallons, or 10 cubic feet, in each 24 hours. The maximum flow of sewage was estimated at one and one-half times the average flow due 10 cubic feet per day. On this basis the maximum flow of sewage to be provided for was:—

$$\frac{800{,}000 \times 10}{24 \times 60 \times 60} \times 1.5 = 138.88 \text{ cu. ft. per second.}$$

This amount was nearly doubled by adding to it 100 cubic feet per second as a provision for rainfall, or about one-fourth inch of rainfall in 24 hours per acre of tributary territory. In practice, however, it was intended to admit little if any rainwater except from regions where the cellars were subject to flooding.

The inclination given the main sewer was 1 in 2,500, and it was designed (as were all the sewers) to flow about half full with the maximum amount of sewage. This rule was adopted because it saved about 3 feet in depth of excavation over the whole system and 3 feet lift in pumping; it also provided storage room for any large additional amount of sewage due to an intermission in pumping or from rain; it likewise gave more head-room for the workmen entering the sewers. In designing the smaller intercepting sewers, the method employed was about as follows:—The district to be drained, and its area in acres, was ascertained; then the largest population which might by any chance occupy this area in the future was—guessed at; the average amount of sewage proper due to this estimated population was next doubled for safety and an amount added for rainfall of about one-fourth inch in 24 hours. If an intercepting sewer large enough to carry this total amount when flowing half full, was still too small to be entered conveniently, its size and sometimes its height only was increased to the required dimensions.

Velocities of flow were calculated by the formula $V = C\sqrt{RI}$, with Mr. Kutter's co-efficients, using .013 as the co-efficient for roughness.

We give Plate 17 from Mr. Clarke as a contrast to the "Common Types" before shown. In this plate, Figs. 1 and 2 show the usual method of constructing the main sewer which is 10 feet 6 inches in inside diameter to the junction with the South Boston intercepting sewer; rubble side walls were built for the greater portion of the distance. Fig. 3 is the bond used in the spandril; Figs. 5 and 6 are man-hole connections, these structures are about 400 feet apart; the wrought-iron step used is shown at Fig. 7, and the man-hole cover and bucket at Fig. 8. This cover and bucket (further shown in Plates 18, 19) has been very generally adopted in the improved sewerage, and is found to answer well; the cover is perforated for ventilation, and the design shown is the result of careful study and trial as to the size of openings, arrangements of ribs, etc. The bucket is intended to catch any detritus from the roadway and prevent miscellaneous rubbish from passing into the sewer; they are made of galvanized iron well coated with tar, and can be lifted out, emptied and replaced, as occassion may require. Fig. 9 shows a portion of the sewer where it was tunnelled through conglomerate rock and coarse sand. Fig. 10 is a part carried over a bed of marsh mud 20 to 86 feet deep; in this case the intended street was first filled in and the sewer built of wood in this filling, as shown, and finally lined with 4 inches of brick work. The wooden shell was formed of 4-inch spruce plank, 10 inches wide, every fourth plank wedge-shaped, and the whole spiked and tree-nailed together. The average cost per lineal foot of this sewer complete was $56. It has now settled in a long curve, 18 inches below the original grade line at the center; but has received no apparent damage. Fig. 11 shows

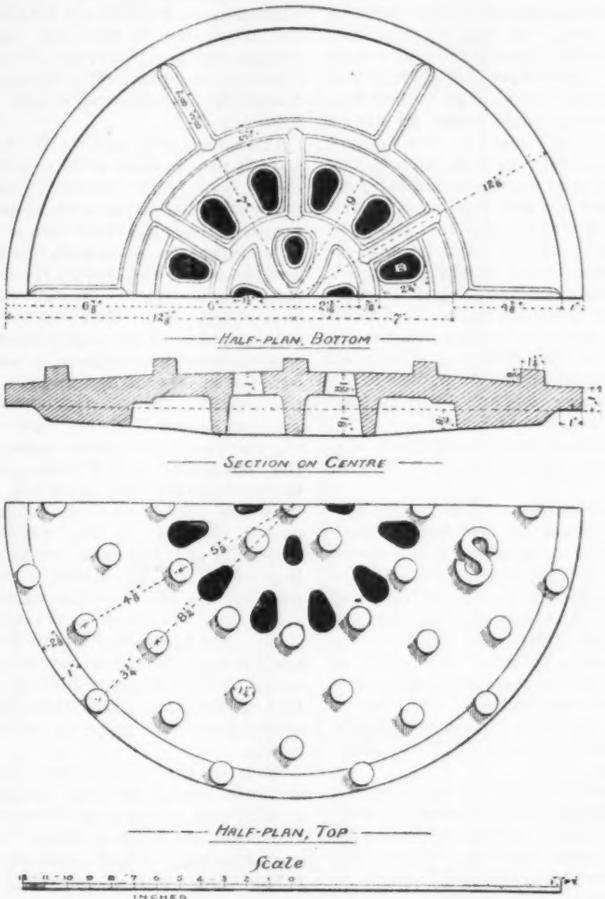


Plate 18.—Ventilated Man-hole Cover.

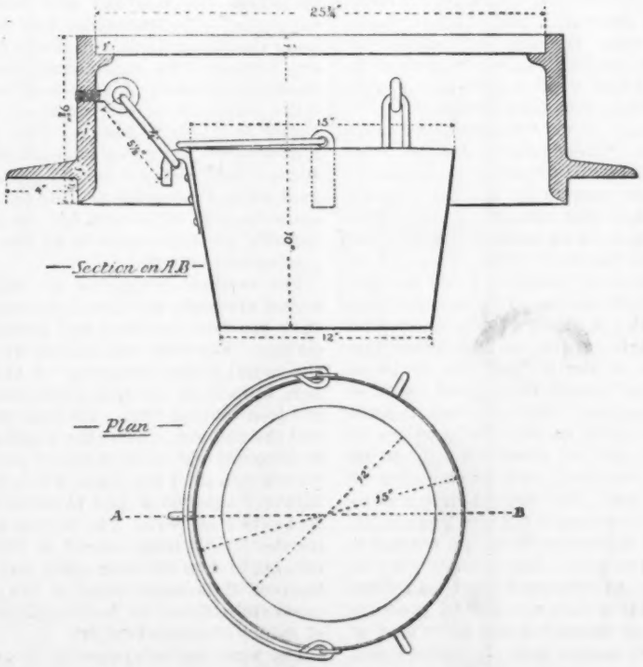


Plate 19.—Catch-bucket under Ventilated Man-hole Cover.

a portion of the sewer where it passed within 35 feet of a large gas-holder, sheet piling was here used as a precaution, and the trench was back-filled with concrete to crown of the arch. Figs. 12 and 16 are side-entrances and boat-chambers, the opening to the street being rectangular, 11 by 4 feet, to permit a boat to be lowered. Fig. 13 shows a pile foundation. Figs. 14 and 15 are tunnel sections, and Fig. 4 shows a portion of sewer broken by improper back-filling and afterwards rebuilt. The total cost of 3.2 miles of main sewer was $606,031, or an average of $36.09 per lineal foot.

TO BE CONTINUED.

Railway Safety and Economy.

Mr. C. P. Sandberg has prepared for the Institution of Civil Engineers a paper on "Rail Joints and Steel Rails," which call attention to several important defects in the present systems of railway permanent way, and offers suggestions for their improvement. The first part of the paper deals with the fractures of rail joints in the United States, which have of late been very frequent, but hitherto no similar experience has occurred on European railways using the same form of rail joints. The author believes that in the United States both the rails and the rail joints are becoming too weak for the greatly increased traffic, although they may have been sufficient at the time the roads were laid down. The second part of the paper refers to the wear of steel rails in different countries, and the author shows that the English railways, in substituting steel for iron rails, increased the weight of the rails in order to meet the requirements of a heavier traffic; whereas on the Continent of Europe as well as in the United States of America this has not been done. The practical result of this state of things is found to be that English railways, so far as the permanent way is concerned, are the best in the world, and achieve a *maximum* of safety and economy in maintenance of road and rolling stock, notwithstanding that higher speeds are employed than anywhere else, not to speak of the greater comfort of traveling on good roads. On the Continent of Europe the flange rail generally employed is in many localities much to weak. Some of the Continental railways have quite as heavy traffic as the English trunk lines, and even heavier engines are employed; but the permanent way has by no means been strengthened to the same extent. The needs of international through traffic as now carried on, demand in the author's opinion, the use of heavier permanent way, and he calculates that to meet such requirements, the flange rails used on Continental lines should, to compare with English lines in cost and efficiency, weigh not less than 100 pounds per yard, instead of 70 pounds to the yard, the weight of the rails now used. The author also believes that in many cases where steel have superseded wooden sleepers they have not been sufficiently strong, and that in order to effect the increased economy anticipated from their use, they should be made considerably stronger than those hitherto laid down.—*Herapath's Journal.*

TILE DRAINS AND HIGHWAYS.—Hon. E. M. Haines, of Waukegan, Ill., President of the State Highway Commission, has written to Col. Charles F. Mill, Secretary of the State Board of Agriculture, in which he suggests that the tile-makers of the State and the Commissioners of Highways hold a joint Convention in Springfield, Ill., April 27 next, for the purpose of taking concerted action in regard to a system of improving the public highways by tile draining and otherwise.

Proposed Harlem River Bridge: First Prize Plan.

The project of bridging the Harlem river in the immediate neighborhood of the High Bridge has been agitated since 1869. It was at first in the hands of the Commissioners of the Department of Public Parks, and in 1883 this Commission called for plans under an Act of the Legislature of 1874 and received designs for both stone and iron or steel bridges, but no action was taken in the matter. Last year (1885) a new and special Commission was formed, composed of three members, one to be appointed by each of the following city officials, viz: the Mayor, the City Comptroller, and the President of the N. Y. Board of Aldermen. Under this latest Act of the New York Legislature, an Act which gave almost unlimited powers to the Bridge Commission, Messrs. Jacob Lorillard, David James King, and Vernon H. Brown were appointed as Commissioners and under date of October 22nd, 1885, these gentlemen invited engineers and bridge builders to tender plans for the proposed structure.

The site of the bridge across the Harlem river was to be north of the present High Bridge, and "not more than half a mile therefrom;" the river at this point is 400 feet wide between the established bulk-head lines and the banks are high, rocky and precipitous. The purpose of the bridge was the improvement of this annexed district of the City of New York, by providing means of communication between the two banks of the river in connection with the long-talked-of improvement of the Harlem river itself for commercial purposes.

The "memoranda" issued by the Commissioners, under the date above given, specified that the bridge and its approaches would be about 2,000 feet long; that the "clear river space between the bulkhead lines" should be 400 feet; the roadway of the bridge at least 145 feet above mean high tide, and the width of the bridge at least 80 feet, viz: 50 feet of roadway and two sidewalks, each 15 feet clear. The passage-ways beneath the bridge for streets, avenues and railroads were defined in location and width upon a plan and profile submitted to those proposing to tender.

The following were "suggestions" presented with the "memoranda" for the guidance of engineers, and departure therefrom in plans submitted was to be specially noted upon such plans:—The masonry of piers, abutments, etc., was to be on solid rock, though, if directed by the Engineer, piers supported on piles surrounded by concrete would be permitted in certain places. The masonry was to be faced with granite, and the interior stone was to be granite, gneiss, or limestone. The superstructure of the bridges was to be of steel, excepting certain designated parts of wrought or cast-iron. This steel was to have an ultimate strength on full-sized sections of 60,0000 pounds, and an elastic limit of 36,000 pounds per square inch, with an extension of at least 10 per cent. The wrought-iron was to have an ultimate strength of 45,000 pounds, an elastic limit of 26,000 pounds and an extension of at least 10 per cent. The bridges were to be designed for an estimated dead load of 200 pounds per square foot, also a wind pressure of 400 pounds per lineal foot and a live load of 100 pounds per square foot of roadway and footwalk.

These being the general conditions under which engineers were called upon to submit plans, and Hon. Wm. J. McAlpine, C. E., being appointed as Consulting Engineer to the Commission, a number of plans were presented in competition for the three prizes offered, of $1,500, $1,000 and $500 for the three designs selected; all designs were to be accompanied with specifications and approximate estimates of cost. The second prize plan designed by Wilhelm Hildenbrand, C. E., was illustrated in the last issue of this journal; the first prize plan of C. C. Schneider, C. E., the designer of the Niagara Cantilever bridge, is now illustrated and described as follows:—

The bridge proposed by Mr. Schneider consists of two metallic arches, each of 410 feet clear span, with masonry piers and approaches. One of the main arches spans the entire width of the river with a clear height of 110 feet above mean high tide at the center, and the other arch covers the whole distance from the eastwardly bank of the river to Sedgwick Avenue. The masonry approaches on both sides are as nearly symmetrical as it was possible to make them, so as to accommodate the street crossings and the conditions of the profile. These approaches consist of masonry arches of 80 feet clear span, retaining walls and plate-girder spans across both the Boulevard and Boscobel Avenue. The grade of the roadway is 150 feet above mean high tide. The floor of the bridge is 80 feet wide in the clear, 50 feet roadway and two sidewalks of 15 feet each; with an ornamental iron railing on the outside of each footwalk over the metallic portions of the structure, and a stone balustrade over the masonry portions. The footwalks over the piers are bayed and the space thus provided is furnished with seats. Communication between the bridge and the Boulevard and Boscobel Avenue is afforded by stone steps on each side of the bridge.

Each of the main spans consists of six separate braced metallic arches, spaced 14 feet between centers and connected laterally and transversely by a system of lateral and sway-bracing. These arches support the bridge floor on iron columns, which latter carry longitudinal girders, to each of which transverse iron floor beams are attached, and on which the roadway and footwalks are supported. The transverse floor beams overhang the arches 6 feet, and the projecting ends are supported by ornamental brackets, thus forming a cornice. A cross-section of the metallic structure at the center of the arch is shown in Plate 2, Fig. 2. The arches are hinged at the springing in order to make the strains well defined and capable of exact analysis and calculation. The detail drawing shows the end of the arch and the hinge. The metallic superstructure is of the American pin-connection type.

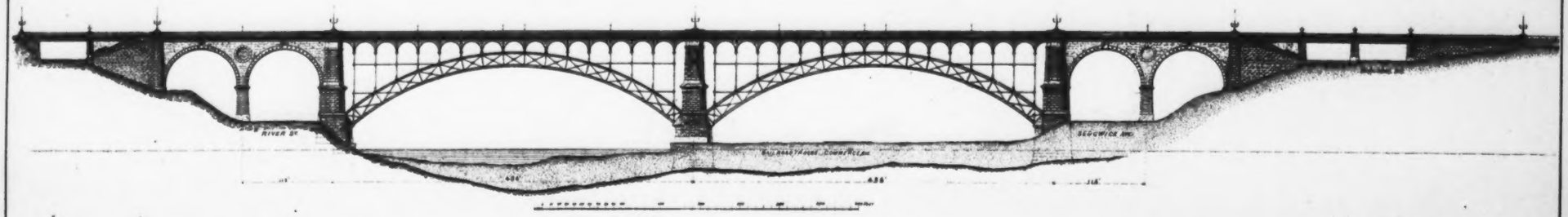
The sections composing the chords of the arches are made up of steel plates and angles; they are two feet deep and latticed top and bottom. The web system is of wrought-iron, the radial struts consisting of 12-inch channels, latticed on the open sides; the diagonals are iron tension bars. All pins are of steel, and the end pin forming the hinge is 20 inches in diameter and rests on a steel pedestal, supported on a steel bed-plate, which rests on the masonry skew-back and is anchored thereto by heavy steel bolts. The vertical posts carrying the floor-system consist of 12-inch channels latticed on the open sides and hinged to the pins of the upper chord of the arch; these posts are stiffened by horizontal struts made of 10-inch channels latticed.

The wind and sway-bracing is arranged in the following manner:—Horizontal struts are attached to the main pins in the upper and lower chords of the arches and to the vertical posts at the points of intersection with the longitudinal stiffening struts, connecting the arches and vertical posts transversely. These struts consist of 7-inch channels latticed, and

PROPOSED HARLEM RIVER BRIDGE.

DESIGNED BY C. C. SCHNEIDER, C. E., NEW YORK.

(For Description, see Page 129.)



AWARDED FIRST PRIZE BY THE HARLEM BRIDGE COMMISSION,

1886.

the bents thus formed are braced laterally and transversely by iron rods.

The roadway is of plates of corrugated iron, ¼-inch thick, resting upon the longitudinal floor beams and covered with concrete shaped to the cross-section of the roadway. On top of the concrete is a layer of Trinidad asphalt and above that blocks of granite 7 inches thick. The footwalks are paved with diagonal tiles of blue stone, with rows of white marble tiles on each side and a granite curb. These footwalks are laid on concrete, supported by corrugated iron as under the roadway.

For all parts of the metallic structure mild steel and wrought-iron are to be used, cast-iron being employed only in the cornices and ornamental parts.

The foundations of the piers are to be carried to the solid rock. The masonry is to be faced with granite laid in courses 20 to 30-in. thick; the interior to be of limestone or other approved stone in courses corresponding with the face work, and all masonry will be first class, rock-faced work, with beds and joints dressed to one-quarter inch, excepting coping, cornices and parapets which are to be fine cut work.

The structure is proportioned to sustain the following loads, viz:—

Besides the weight of the structure itself, a floor weighing 200 pounds per square foot, and a live load of 100 pounds per square foot, considered in positions and under conditions giving the greatest results.

The floor girders are proportioned for a 20-ton street roller of the usual pattern.

Strains resulting from changes of temperature have been provided for, corresponding to a variation of 150° Fahr.

The maximum and minimum strains in compression and tension as found for the above mentioned loads, were used in determining the permissible working strain in each member of the structure according to the following formulæ:

For members subject to one kind of strain only (all tension or all compression):

$$a = 10{,}000\left(1 + \tfrac{1}{4}\frac{\text{Minimum } S}{\text{Maximum } S}\right) \text{ for wrought-iron}$$

$$a = 12{,}000\left(1 + \tfrac{1}{6}\frac{\text{Minimum } S}{\text{Maximum } S}\right) \text{ for steel}$$

Maximum S denoting the greatest and Minimum S the least strain which comes upon a member.

For riveted work in tension, only nine-tenths of the permissible strain a per square inch of net section has been allowed.

For pieces subject to alternate strains of tension and compression

$$a = 10{,}000\left(1 - \tfrac{1}{4}\frac{\text{Minimum } S}{\text{Maximum } S}\right) \text{ for wrought-iron}$$

$$a = 12{,}000\left(1 - \tfrac{1}{6}\frac{\text{Minimum } S}{\text{Maximum } S}\right) \text{ for steel}$$

Minimum S denoting the smallest and Maximum S the greatest strain upon the members according to their numerical values and regardless of their signs.

For compression members, the allowed working strain per square inch is reduced according to the following formula:—

$$b = \frac{a}{1 + \dfrac{a\,l^2}{8\,E\,r^2}}$$

where a = permissible strain previously found.

b = allowed working strain per square inch.

l = length of member in inches.

r = least radius of gyration of the section in inches.

E = modulus of elasticity of the material, which has been assumed as 26,000,000 for wrought-iron as well as for steel.

In members subject to combined compression and transverse strains, the maximum compression per square inch on extreme fiber shall not exceed the allowed working strain b for compression members.

The shearing strain on rivets, bolts or pins per square inch of section shall not exceed four-fifths of the permissible strain a per square inch; and the pressure upon the bearing surface of the projected semi-intrados of the rivet, bolt or pin hole shall not exceed one and one-half times the permissible strain a.

The bending strain on the extreme fiber of pins shall not exceed 15,000 pounds per square inch for iron and 20,000 pounds per square inch for steel.

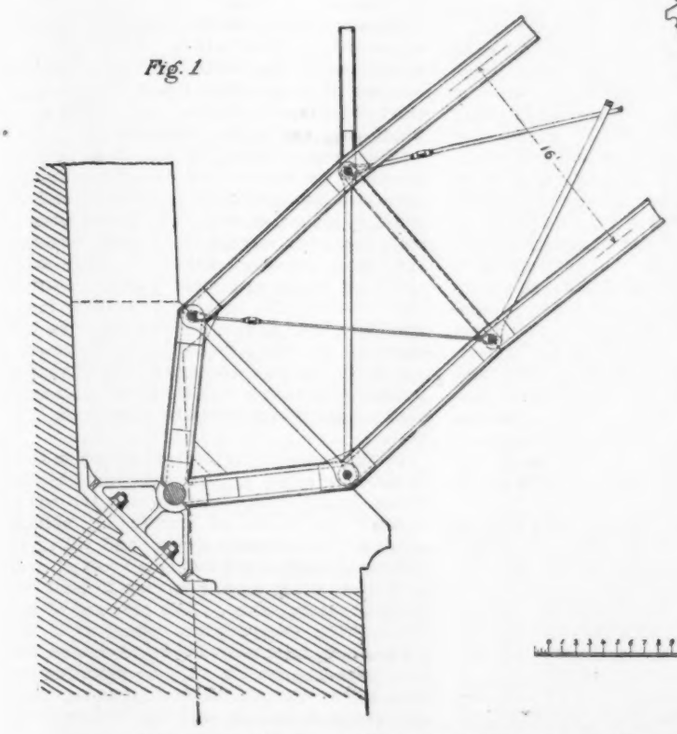
The wind bracing is proportioned for a wind pressure of 400 pounds for lineal foot. The strain allowed on lateral and sway-bracing, and all other members, which are strained by wind pressure only, shall be 15,000 pounds per square inch for wrought-iron and 18,000 pounds for steel, properly reduced for compression members.

All parts of the metallic structure are so designed that the strains coming upon them can be accurately calculated. And all details are arranged so as to be accessible for inspection, cleaning or painting. No metal is used less than ⅜-inch thick. The pressure of bearing plates on the masonry has been limited to 250 pounds per square inch.

In this design, as will be seen by reference to the plans, no attempt has been made at elaborate ornamentation; the object of the designer having been to make the structure well proportioned in all its parts, symmetrical as a whole, imposing in appearance in keeping with the magnitude and importance of the work and as an example of the best practice of modern bridge engineering.

The estimated cost of the whole structure complete is $2,075,000. The quantities of material in the structure are as follows:

110,000 Cubic yards, Masonry.
12,000 " " Concrete.
3,600 Square " Granite block pavement.
57,000 " feet, Blue stone and Marble tile footwalk.
2,000 Lineal " Stone balustrade.
6,000 Tons, Iron and Steel.
2,040 Lineal feet, Hand-railing.



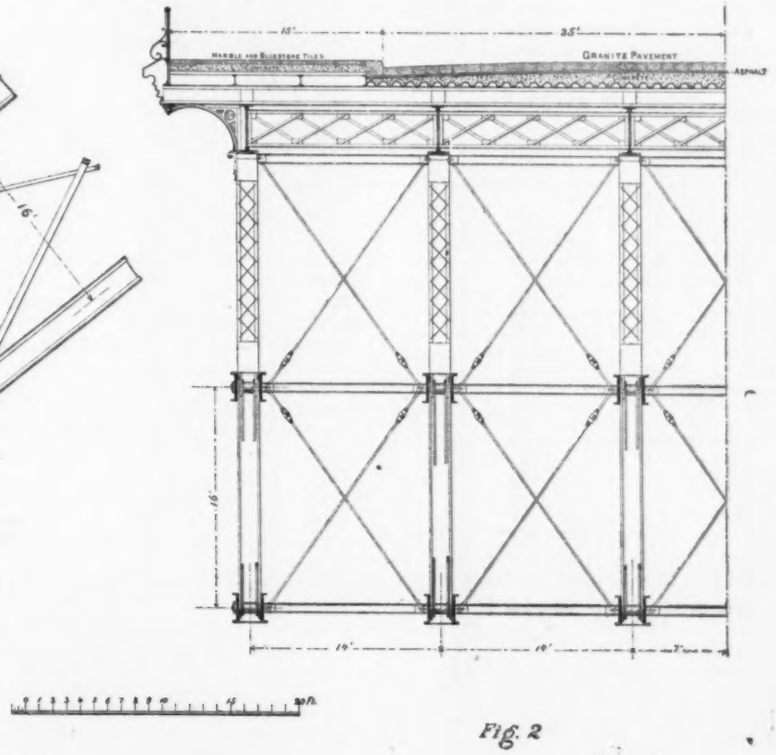


Fig. 2

Plate 2.—Harlem River Bridge: Details. Fig 1. Detail of Hinge at Springing of Arch. Fig 2. Hal Section at Center of Arch.

ENGINEERING NEWS
AND
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THE reports of Messrs. Church, Birdsall and Adams, three civil engineers of ripe experience, who have devoted some decades of their professional lives to the study of the requirements of the Croton water-shed, should be a sufficiently convincing answer to the query as to "Why the Quaker Bridge Dam should be built."

As Mr. Adams remarks, the query itself is a peculiar one to come from the Aqueduct Commission at this stage of the game; and it looks very much as if the said Commission was thus seeking an excuse before the public for the two years wasted in listening to a choice display of professional ignorance and nonsense as exhibited in the testimony of would-be experts, congressmen, committees of the Union League Club and other outside obstructionists.

The subject of the water-supply of New York is somewhat too intricate to be intelligently handled by club committees and imported experts; and, as before shown in these columns and especially in the report of Mr. Adams, it is very important to be certain of your premises before deducting a paper estimate based on "averages" and "storage reservoirs" which do not store water. After all the time spent in "public hearings" we are just, first where we started minus two years of valuable time for which the citizens of New York may yet have to pay dearly.

IN their answer to the queries of the State Legislature the Harlem Bridge Commission, as elsewhere shown in this issue, testify that while more expensive in first cost a composite arch of stone and béton would be more economical than a metallic structure, and an all stone arch better than either, but too costly to be considered.

We do not doubt for a moment from an esthetical stand point, but that an arched masonry structure is peculiarly well adapted to the high bluff banks and the picturesque surroundings of the site proposed; the High Bridge near by is proof sufficient on that point, and it is one of the most eye-satisfying engineering structures in our country.

But when it becomes a question of comparative wear or lasting qualities, between stone or composite arches of great span and a metallic structure, such as proposed for this crossing, we must differ with the expressions of the Commission, as we understand them. With comparatively short, all stone arches, we should not hesitate to say that they would be in the end more economical and last longer than short metallic spans subjected to constant and great vibration, and the deterioration of fiber and loss of section in light members from oxidation.

With a stone arch of 280 feet span *vs.* an iron or steel structure of 400 or more feet span, the economical and wearing features of the problem assume quite a different shape. The stone arch proposed would doubtless be a grand feature in the landscape, but it would cost more money than the metal arch of nearly twice the span, make foundations necessary for an additional pier in the river and in so much further obstruct the waterway. The only merit of such an arch, aside from its beauty, would be its superior lasting qualities. But here is just where we are inclined to doubt. A metal structure of the designs suggested would have such an enormous dead weight compared with any ordinary moving load, that it would not be subjected to the destructive vibrations which would seriously effect a short metallic span; its main members would be so massive that nothing short of criminal neglect would dangerously reduce their section by rust; and as to maintenance, while one type of bridge requires painting to preserve it, the other requires pointing under the changes of our climate.

Though we can not point to examples of iron bridges of great age as we can to stone arches of the Roman Empire, it is simply because the manipulation of iron and steel in great masses, and the knowledge of best adapting it to its work, is a discovery of very modern times. Left to themselves and the elements through ages, the stone would very probably outlast the best iron bridge; but if properly built in the first place, and properly cared for afterwards, we believe that it is possible, if not probable, for an iron or steel arch of great span and consequent weight to last just as long as a stone arch of between 200 and 300 feet span.

We learn from the London *Financial News* that the Association for the Defence of the Economic Interests of the Rhineland and Westphalia at a meeting held at Dusseldorf the other day adopted the following resolution:—"The extremely critical situation of the Rhenish and Westphalian coal industry, and the inevitable effect sooner or later of a continuance of this situation upon the position of the numerous laborers employed in this and kindred industries, make it absolutely necessary that the railway tariffs should be lowered in the direction of the North Sea ports, Holstein, Switzerland, and Italy, not only that our markets may be extended, but even that they may be retained."

This industry has great consideration from the German Government and from the German people. Not only do the steamships use German coal, but the Government railroads give them very low rates, *e. g.*, from the Westphalian mines to Hamburg, with a maximum distance of 226 miles, the rates are for home consumption $1.44, for export $1.32 per ton; these rates, $6\frac{37}{100}$ and $5\frac{84}{100}$ mills per ton mile, pertain to the whole group of mines, and the mean would be slightly higher.

In this country the railroads to a great extent own or control the coal mines, and in many instances strive not only that their markets are not extended but are restricted; as a consequence the consideration they receive from the mass of the American people is not in general of a flattering kind.

The Harlem River Bridge Report.

The Harlem River Bridge Commission, under date of Febuary 16th, and in answer to a resolution of the New York Legislature, asking for a copy of the contract entered in for the construction of the said bridge, answer as follows:—

They say that in the first place no contract has yet been entered into by the Commission, consequently the terms of such contract can not be given. The Union Bridge Company did make a proposal, but it was never finally accepted by the Commission.

Of the plans submitted, the first were all masonry; the second, of stone approaches and piers and iron or steel superstructure, and the third, of all iron or steel. The Commissioners state that after careful study and consideration they concluded that an entire stone structure would cost more money and time than they thought they were justified in expending; but finally decided that an all-masonry structure would be more durable, suitable to the surroundings and cost less for maintenance than a composite bridge, though such a stone bridge would be greater in first cost.

Taking these things into consideration they decided to adopt a plan submitted by the Union Bridge Company, in which the whole exterior was to be of granite or natural stone, and the interior arches and filling of "Béton Coignet;" the estimated cost of such a structure being much less than if built entirely of natural stone. This proposal of the Union Bridge Company was submitted in the form of a contract signed by the company, but not by the Commission. Upon submitting the proposal to the Corporation Counsel, this official stated that it was unsatisfactory to him in its original form; and the question also arose as to the legality of using "Béton Coignet" under the strict construction of the word "stone" in the act. The Union Bridge Company, finding the matter was involved in legal doubt, thereupon withdrew their proposal.

The Commission, having become satisfied that they must dismiss the idea of an all-masonry structure of any kind and confine themselves to a composite bridge of stone and steel or iron, now turn to the designs for which prizes were awarded. The first prize was accorded to C. C. Schneider, C. E. (whose plan is given in this issue of ENGINEERING NEWS), the estimated cost being $2,075,000; the second prize was awarded to Wilhelm Hildenbrand, C. E., (plan shown in last issue of this journal) at an estimated cost of $2,250,000.

The Commissioners conclude their report by stating explicitly that they have now eliminated all entire masonry structures, whether of natural stone throughout or part "Béton Coignet;" and that they shall decide at once upon the best plan for a composite bridge of stone and iron or steel superstructure, and begin forthwith the construction of the bridge by contract or contracts.

The Panama Canal.

Our advices from the Isthmus up to the 14th inst. assure us that the people there are confident of a favorable report by Mr. Rosseau. As there has been a recent accession of engineers mostly "chiefs" to fill the places temporarily occupied by persons from the lower ranks, in consequence of deaths, and as recent despatches from France assert that more are coming, the business men are feeling more jubilant and were setting poles and flag staffs in the Plaza of Panama so as to welcome de Lesseps with garlands and bunting.

At the same time the air was full of a rumor, which could not be traced to any canal official, that de Lesseps would accept the necessity for locks. This has long seemed to us the only possible basis on which more money can be raised, and if it is done, we can rely on its being done thoroughly and with a very considerable blast of trumpets. However this may be the engineers there present are extremely busy and are making a thorough inspection. Instead of four divisions there are hereafter to be five.

All the work is under contract except dredging in the Bay of Panama which Calahan is negotiating for.

Ten new dredges are to be built to excavate between kilometres 26 and 36, de Marteau's contract.

Slavan is said to have excavated 650,000 cubic metres in January; not a great deal more can be done this season, as the working weather is wearing away, and it will take some time to get the new organization working properly.

There is a call for information about, and prices of wheel and ordinary scrapers, also contractors' railroad supplies, rock drills and material for a telegraph line. If our advertisers will forward us price lists, etc., of such articles, we will be glad to send them to our correspondent.

Foundations in 300 Feet of Water.

At the Paris Exposition of Contractors Plant, according to *Le Génie Civil*, M. Jandin exhibits a model of a plant designed to sink tubular foundations to a depth of 300 feet or more.

His scheme includes a tube (330 feet in length), which has a bottom diameter of 98 feet and a top diameter of 40 feet. The work is to be done with this tube filled with water. Each ring in this foundation is made up of an interior ring of cut masonry with an enveloping skin of light iron, and an exterior ring of floats filled with air compressed to a degree corresponding to their respective depths of immersion; the purpose being to permit the use of light metal in these floats. The sinking of the tube is effected, after it is floated to its site, by filling the outer envelope with water; and when it rests upon the bottom by forcing cement into these outer cells, which will further protect the pier and, by the added weight, sink it into the bottom material.

The sand, etc., is to be extracted by the compressed air injector dredge of M. Jandin, (to be described in next issue) and the sinking continued until hard bottom is reached. The filling of the tube is to be accomplished by a tube similar to the injector dredge, but provided at the top with a "béton lock." Into this lock the sand, cement, etc., are put dry, and compressed air is admitted upon it, forcing it down and delivering it at the bottom of the tube almost dry, there to be mixed with the water.

Le Génie Civil, in criticising this scheme which is actually proposed for a bridge across the Straits of Messina, makes some very pertinent remarks regarding its feasibility. It says that one of the chief difficulties in such a case will be to ascertain beforehand the depth at which sufficiently firm material may be found; and if it is admitted that such data can be well established by soundings, the handling of this long tube and its sinking in a truly vertical position will be a very delicate operation in swift currents, such as would be found at the proposed site. And a very serious question to be solved is whether the injector dredge is capable of raising material through depths ranging to 330 feet with any amount of air pressure; and if raised, whether it will do it in a regular manner over so large a bottom surface. The latter objection applies also to the placing of the béton from so long a tube. We hardly think an engineer would care to trust a costly bridge structure upon a foundation thus provided.

PERSONAL.

FRANKLIN WRIGHT, a civil engineer, who was engaged in the construction of several of the leading railways of the United States, died February 17th at Petersburg, Va., aged 78 years.

J. C. DOWD, Roadmaster of the Missouri and Arkansas Division of the Texas and St. Louis Railroad, has resigned; to take effect March 1st. It is understood that Mr. Dowd will accept a similar position on the Louisville, New Orleans and Texas Railroad.

W. K. FLYNT, superintendent of the Flynt Building and Construction Company, and also at the head of the extensive Flynt granite quarries at Monson, died at Palmer, Mass., February 22nd.

The following notice has been issued from the office of President Frank S. Bond, of the Cincinnati, New Orleans and Texas Pacific Railroad: "MR. G. BOUSCAREN having tendered his resignation as consulting engineer of the Associate Railways; it is accepted to take effect on March 1, 1886, from which date the office of 'consulting engineer' will be discontinued."

MR. H. P. FEISTER, having resigned the General Superintendence of the Franklin Machine Works, Philadelphia, has opened extensive offices in the new Haehnlen Building on Library street, where he will devote his entire time and attention to civil and mechanical engineering and to the manufacture of his well-known improvements in printing and book perfecting machinery.

MR. COPE WHITEHOUSE. Those who remember the very interesting address of this gentleman, before the American Society of Civil Engineers at Buffalo, on Lake Moeris, and its re-utilization as a reservoir for the flood waters of the Nile, as described by Herodotus and other historians, will be pleased to learn that the Egyptian Government has instituted surveys to determine the practicability and expense of restoring that vast natural reservoir to its old usefulness, both as supplementing the irrigation of the Nile valley and giving fertility to the adjacent country.

If this scheme is found practicable, Mr. Whitehouse must feel abundantly repaid both for his studies and physical investigations.

PHINEHAS POMEROY, one of the oldest civil engineers in the west, died at his home in Winchester, Ind., February 13th, aged 85 years. MR. POMEROY began his career as an engineer on the New York and Erie canal in 1820, and followed his profession to the last. He was perhaps the only surviving man engaged with DeWitt Clinton in the construction of a public work that opened up the unbroken wilderness of the west and gave an impetus to the improvements that have made it the center of civilization on this continent. He came to Ohio in 1825, and was engaged with the late Alfred Kelley, of this city, and his associates in the construction of the Ohio canal system. When railroads came to the front he was engaged on the Mad River & Lake Erie railroad, the Little Miami, and was either locating or consulting engineer on most of the roads built in southern Ohio, Indiana and Illinois up to the last ten years. In 1840 he was called to Kentucky to look after the internal improvement system of that State at the solicitation of Henry Clay. Soon after he became associated with Colonel W. R. McKee, who was killed in Mexico, in the construction of the railway from Frankfort to Lexington. MR. POMEROY is the last of the first promoters of public works in Ohio; engineers and contractors so far as known are all gone. His son and other relatives are still residents of the city of Columbus.—Ohio *State Journal*.

The American Institute of Mining Engineers.

The convention of the American Institute of Mining Engineers, which has been in session at Pittsburg, adjourned on the 19th inst., after electing the following officers: President—Robert H. Richards, Boston; Vice-Presidents—W. B. Cogswell, Syracuse, N. Y.; James F. Lewis, New-York City; J. D. Weeks, Pittsburg; Managers—H. M. Howe, Boston; J. E. Johnson, Longdale, Va.; W. G. Neilson, Philadelphia; Secretary—R. W. Raymond, New York City; Treasurer—Theodore D. Rand, Boston.

Ohio Tile Makers and Drainage Association.

Reported for ENGINEERING NEWS.

The Annual Convention of the Tile Makers' and Drainage Association of Ohio was held in Columbus, O., in the Board of Trade rooms on Tuesday and Wednesday, February 9th and 10th, J. G. Wagner, of Covington, O., being President, and A. O. Jones, of Columbus, O., Secretary.

Tuesday forenoon was devoted to the reading of the minutes of the previous meeting, the transaction of general business and the greetings of old and new acquaintances.

In the afternoon the first paper presented was on "Tile Making and Tile Using," by J. J. W. Billingsby. The paper was very practical, and was mainly devoted to the enumeration and consideration of the "little things," which go far toward either making the business a success or a failure. Proper examination and study of the clay used, the location of the works in relation to the clay bank, the method and cost of getting the clay from the bank to the works, attention to the machinery, economy of steps in getting the tile from the cut-off to the drying room and to the kiln, and away from it, setting the tile to dry, even drying, chipping and marring, waste from water-smoking, badly regulated heat, careless yarding, selling the tile without knowing just what they cost in money and labor, taking an interest in them and results best from them after they are sold, size, system working, even grade, perfectly formed tile, faithful help,—each and all were held up before the Convention as matters, which require sharp business practice and must be attended to closely, or failure be the result.

At the conclusion a vote of thanks was tendered to Mr. Billingsby and the paper ordered to be printed.

The discussion that followed was general, and very interesting. Members reported that by attention to matters they had learned at previous meetings they were making half as much more tile for the same money. The cost of getting the clay from the bank to the works was shown to vary from less than ten cents to seventy-five cents per ton. Certain clays have to be slacked the same as lime, except in the spring-time, either by keeping it wet in the bank, or by letting it stand with water on it for forty-eight hours before use. The discussion was closed by the President to give time for other work, but it was voted to resume it in the evening before the regular time for meeting.

The next was an address by J. W. Penfield, giving a brief history of tile making in Ohio, and some bits of his experience as a manufacturer of tile machines. The first tile made in Ohio was in 1852.

The question-box was an interesting feature of the Convention. In it persons dropped such questions as they wished to have answered, and these were distributed by the President among those who were to answer, or lead in the discussion. The first question was, "Can this Society adopt uniform prices?" The answer, by Mr. Billingsby, was,

yes. "Is it practicable?" This he answered in the negative. There were not more than one hundred in the Convention, out of six hundred in the State, and the Society's action would not be binding on outsiders. Then there was a great public feeling against anything that savored of monopoly. It costs some men more than others, and each is needed in his neighborhood. Some clays work easy, and others hard. The price must be governed by the supply, the demand, and the surroundings. "Will the large manufacturer succeed in breaking up smaller ones?" No, on account of transportation, which, if long, the tile will not stand. Inquiries of late have been received from Arkansas, Missouri, Alabama, Texas and Mississippi, in regard to tile machines. Tile drainage is becoming popular everywhere.

"Should brick-makers establish a standard size for bricks, the State over?" Answered by Mr. Endaly in the affirmative.

"What is the cheapest and best plan for artificial drying?" A vexed question, but Mr. Endaly claimed that the method of drying in tunnels was the best, and that it cost him from ten to fifteen cents per thousand brick to dry them in this way, and requires one day's time. "Can four-inch tile be made for 28 cents per rod, when labor is $1.25 and coal $2.75?" The discussion was becoming interesting, and it was decided that it was not wise to discuss such questions in open meeting, and it was dropped. The newspapers might tell.

"How much does clay lose in weight in drying?" Answered by Mr. Penfield. It depends on the kind of clay, and the moisture in it. Generally a wet brick will weigh 7½ pounds, a dry brick, 6½ pounds, and a burnt brick 5½ pounds.

"How can increased attendance at the meetings be secured?" Several ways were suggested, and the matter was left to the committee on programme appointed for next year, E. B. Endaly, and A. O. Jones.

In the evening, Professor N. W. Lord, of the Ohio State University, addressed the Society on "Fuel and Combustion." At the conclusion an interesting discussion began on methods of firing to the best advantage. The Professor claimed that many failures were due to the admission of more cold air than was necessary for combustion, which had to be heated. This view was substantiated by a member who said that when he first began to fire a boiler he was greatly troubled by the amount of dense black smoke coming from the boiler. By studying and experimenting he found that by not allowing any air to enter through the ash pit, he got more heat, and there was almost no smoke at all. An old white-headed German then told the Society that he kept his flues and pipes free from the collection of soot by burning potato peelings in the stove. He said it was simple and he could'nt tell why it kept the flues clean, but it did.

Wednesday morning, L. W. Matthewson read a paper on "The Science of Practical Tile Drainage." and Professor N. S. Townsend, of the Ohio State University, a paper on the "Influence of Thorough Drainage on Climate." W. S. Chamberlin, Secretary of the Ohio State Board of Agriculture, had prepared a paper on "Tile Ditching and Ditching Machinery," which, owing to his absence, was read by J. W. Fleming. Earnest discussions followed each paper.

In the afternoon an excursion was made to the works of A. O. Jones. The following officers were elected: *President*, J. G. Wagner, Covington, Ohio; *Vice-President*, W. A. Endaly, Cincinnati, Ohio; *Secretary*, A. O. Jones, Columbus, Ohio; *Treasurer*, J. W. Eversall, Westerville, Ohio. The attendance at the meeting was between seventy-five and one hundred.

Illinois Association of Engineers.

In response to the circular issued some time since by Prof. I. O. Baker, to the Civil Engineers and Surveyors of the State of Illinois, a goodly representation assembled at Champaign on Wednesday, February 19, "for the purpose of organizing a State Society of Engineers and Surveyors." The meeting was called to order at 3 P. M. by I. O. Baker, who after a few remarks nominated A. H. Bell for temporary President. Mr. Baker was subsequently elected Secretary.

On motion the following committees were chosen: on organization, Messrs. C. G. Elliott, G. F. Wightman, and T. L. Johnson; on programme, G. T. Ela, Daniel Gordon, and D. J. Stanford. The committee on organization after a short deliberation recommended the immediate appointment of a committee to draft constitution and by-laws, and proposed the following officers to serve during the present session of the Society:—

President, J. O. Baker, *Vice-President*, Daniel Gordon, of Moline, and *Secretary* and *Treasurer*, A. H. Bell, of Bloomington. The officers were elected as suggested. Professor Theo. B. Comstock, who has been of great assistance in bringing about the meeting and who is very enthusiastic on the subject of the organization of a State Society, made some very valuable remarks to the members. Mr. Shreve of Bucyrus, Ohio, and Mr. Hodgman, of Climax, Michigan, gave accounts of the manner in which their respective State Engineering Societies are conducted and offered some very valuable suggestions. Among those who expressed themselves on this point were Messrs. Elliott, Ela, and Gordon. All seemed in favor of establishing a plan of action very similar to the societies in adjoining states. On motion, the chair appointed the following committee on constitution and by-laws: Prof. A. N. Talbot, S. A. Bullard and Richard Gray.

A general discussion then followed on the aims of the proposed organization. It was the opinion of all that the organization should be broad enough to include all classes of engineers. The visiting delegates gave the experience of their respective societies.

The following committee was appointed to draft a constitution and by-laws: A. N. Talbot, S. A. Bullard and Richard Gray.

The programme committee made a report assigning time for the reading of papers and the transaction of business.

EVENING SESSION.

The meeting was called to order with Prest. Baker in the chair. The reading of papers as per report of programme committee began immediately.

First came "Sewerage for Small Cities" by S. A. Bullard, City Engineer of Springfield, Ill. In the discussion that followed the following subjects were brought up:—The relative merits and cost of sewers constructed of tile, brick and stone. Mr. Wightman, City Engineer, of Peoria, Ill., gave his experience with the three materials and expressed himself as strongly favoring brick both for cheapness and durability. He gave an instance of the peculiar effect of the water from an artesian well in Peoria, which discharged considerable sand and gravel into the sewer. In three years time five inches of hard limestone invert have been worn off, and it has been found necessary to replace a considerable portion of the inner ring of brick. Mr. Wightman also gave an instance of a two-foot brick sewer in his city, which even in the heaviest rains is never charged to its full capacity. He is in favor of surface drainage for storm waters so far as possible, but admits the possibility of the advantages of the combined system in other localities. The question of the relative merits of circular and egg-shaped sewers was brought up and discussed. Mr. Bullard stated that in his experience a good brick sewer, 2 feet in diameter, with an average cut of about 9 feet costs about $1.05 per foot, which is materially below that of a tile sewer of equal capacity. However, he does not advise the construction of brick sewers much below 2 feet in diameter.

Next was read a paper on "Land Surveying" by Thos. B. Kyle, County Surveyor of Champaign county. Mr. Kyle gave the results of his experience attending over a long term of years. Among other points mentioned was the capricious actions of the magnetic needle. In the discussion on this subject, an expression was given by Messrs. Clark, Stanford, Gordon, Hodgman and Ela on the relative merits of compass and transit, and the various types of each instrument as contrasted one against the other. It seemed to be quite generally agreed that, with the increasing value of land, more accurate instruments and methods should be employed.

The last paper on the programme was one entitled "Municipal Engineering," by A. H. Bell, City Engineer of Bloomington, Ill. The discussion of this paper was confined mostly to the subject of street pavements. Mr. Bell as well as Mr. Wightman, was loud in his claims for the durability of brick as a paving material, and this, coupled with their comparative cheapness, renders brick pavements the most desirable in the prairie country, except where the proximity of good stone renders the latter a competitor in price. The following prices were mentioned as having obtained at various times:

Brick pavement, (Bloomington),	$1.50	to $1.65	per sq. yd
" " (Peoria).....	1.65	"	" "
Cedar Block " "	1.38	"	" "
" " " (Springfield...	1.38½	"	" "

Although the above figures as given show the cedar block pavement to be considerably cheaper than brick, the fact that the former are not proportionally as durable as brick, renders the latter preferable. Mr. Wightman mentioned in particular a "test crossing" of brick pavement in Chicago. The case cited seemed to show excellent results in favor of brick, even for heavy traffic.

The meeting then adjourned.

THURSDAY MORNING SESSION.

Meeting called to order at 9 A. M.

Programme began with "Drainage Districts and the Construction of Drainage Canals," by A. H. Bell. Mr. Bell showed by his paper as well as by his verbal explanations afterward, that he is thoroughly versed in this branch of his profession. In the discussion of this paper, Mr. Rodgers, one of the contractors in the Piatt County Drainage District, gave a description of his methods for the benefit of those present. Among the most interesting points he spoke of was his description of the effectiveness of their machine in cutting its way through a dense thicket of willows of considerable diameter. Several scoops full of material are taken from about the roots, and then the tree itself is bodily uprooted. Some difficulty is experienced, however, at times, in disengaging the uprooted tree from the scoop. The minor limit to the width of ditch, which their machine can cut, is about 16 feet.

The next paper was "The Highest Attainment in Drainage," by Mr. E. D. Shreve, of Bucyrus, Ohio. This paper showed the writer to be thoroughly conversant with his subject. Considerable discussion took place on the proper adjustment of grades in successive level and sloping stretches of ground. It is the

custom in this State to use as nearly uniform grades as may be, disregarding as much as possible the slope of the ground at any particular point. Mr. Shreve gave some interesting points verbally on the proper sloping of banks, as well as in the disposition of excavated earth.

Next came "Storage Reservoirs and their Effect upon Climate and Navigation," by Daniel Gordon, of Moline, and County Surveyor of Rock Island county. The discussion of this paper was deferred until the first thing in the afternoon session, as eleven o'clock, the hour set aside for a visit to the Mechanical and Architectural Work Shops of the University, had now arrived. The party was piloted in its tour by Dr. S. H. Peabody, the Regent.

THURSDAY AFTERNOON SESSION.

Very little discussion took place on the subject of "Storage Reservoirs."

A paper by C. G. Elliott on "Road Improvement" was then read and thoroughly discussed from many standpoints. Prof. George W. Morrow, Professor of Agriculture, spoke of the matter in a commercial and agricultural light. Messrs. Sager, Hammett, Wightman and Gordon also gave expression to opinions on this paper.

Next came "Bridges" by A. C. Brancher, of Lincoln, which treated almost exclusively of the computation of stresses in the various truss members, the particular case taken being a Warren truss.

Next on the programme was "Pile Foundations" by Fred. W. Sager, of Marysville, O. Mr. Sager began with the early history of pile driving, and traced the progress of this science up to the present time, dwelling at the close of his article upon cast-iron piles, upon which subject he seems to be especially well informed, having made that branch a particular object of study and experiment. Mr. Sager exhibited a collection of drawings and blue prints illustrating cast-iron pile foundation. Among other points of special interest in his paper was a formula for the sustaining power of piles, which the writer claimed to be a close approximation to the truth, having been deduced from a large number of experiments performed by himself. The formula is: "The supporting power is equal to the height of fall in feet multiplied by the weight of the hammer in pounds, and the product divided by forty times the sinking under the last blow in inches plus half an inch."

The meeting adjourned at about 4 P. M., and a tour of inspection was taken through the main building of the University.

THURSDAY EVENING SESSION.

The committee on constitution and by-laws, which had been in session throughout the day, made its report through its secretary, S. A. Bullard. The report, after a few modifications were made, was received and unanimously adopted. Three grades of membership are provided for, viz.:—regular, associate and honorary. The constitution provides for an annual meeting and the publication of the proceedings in an annual volume. The initiation fee is $3.00, charter members included.

The officers for the ensuing year are as follows:

Prest.—I. O. Baker, Champaign, Ill.
V. Prest.—Daniel Gordon, Moline.
Cor. Sec.—S. A. Bullard, Springfield.
Rec. Sec.—A. N. Talbot, Champaign.
Treas.—G. P. Ela, Bloomington.

The executive committee consists of the president and recording secretary, ex-officio, and A. H. Bell, of Bloomington, C. G. Elliott, of Tonica, and D. L. Brancher, of Lincoln.

Adjourned.

FRIDAY MORNING SESSION.

The society met in final session at 9 o'clock A. M. The first part of the morning was employed in the discussion of business matters in general. The proceedings of the Cleveland Convention of Civil Engineers was unanimously ratified, and the following committee was selected to consider this matter: G. P. Ela, of Bloomington, chairman, and ex-officio member of the Civil Engineer's Committee on National Public Works, George F. Wightman, of Peoria, and A. C. Brancher, of Lincoln, Ill.

Mr. C. W. Clarke, of Champaign, U. S. Asst. Engineer on the Mississippi River Survey, then read a valuable paper on "Topographical Surveying," being his views as obtained by a varied experience in river, geodetic and topographical work. This paper was valuable in that it presented many facts relative to the methods, etc., of governmental engineering work, to find which required a large amount of research among the Government reports.

Next came a short paper by Warren Roberts on "The Subdivision of Fractional Sections." This paper treated more especially of the legal phase of the question, and showed its writer to have made a careful research among the proper authorities. Lack of time cut short the discussion on this paper and necessitated the omission of the reading of two papers by Mr. T. A. Enos, of Springfield, on kindred subjects. The papers of the last-named gentleman were, however, voted "read by title," and will appear in the published proceedings.

Addresses of fraternal greetings were then made by the visiting delegates, after which F. Hodgman, delegate from the Michigan Society, and F. L. Sager and E. D. Shreve, delegates from the Ohio Society, were made honorary members.

A vote of thanks was then given to the University Faculty, and others. The Society then adjourned *sine die*.

REGISTER OF ATTENDANCE.

I. O. Baker, Champaign, Professor Civil Engineering, U. of Ill.; J. S. Burt, Henry, Surv. Marshal Co.; D. J. Sanford, Chatsworth, Surv. Livingston Co.; Ezra D. Shreve, Bucyrus, O., Agent Bucyrus Foundry and Mfg. Co. and Delegate from Ohio Society.; R. N. Johnson, Norris City, Co. Surv. White Co.; T. Hodgman, Climax, Mich., Chairman Com. on Manual, Mich. Eng. Soc. and Delegate.; George P. Ela, Bloomington, Surv. McLean Co.; Thos. B. Kyle, Urbana, Surv. Champaign Co.; Daniel Gordon, Moline, Surv. Rock Island Co.; Z. A. Enos, Springfield, Surv.; A. H. Bell, City Eng.; Bloomington, Geo. F. Wightman, Peoria, City Eng.; C. G. Elliott, Tonica, Drainage Eng.; T. L. Johnson, Philadelphia, Pa., representing J. W. Queen & Co.; A. N. Talbot, Champaign, Asst. Prof. Engineering, Mathematics and Drainage, U. of Ill.; Clarence Brainard, Buda, Eng.; Geo. M. Clark, Low Point, Drainage Eng.; Richard Gray, Bloomington, Cast-Iron Piles of the Gray-Abbot Patent; E. A. Hill, Indianapolis, Ind., Eng I. D. & S. R. R.; C. W. Clark, Champaign, U. S. Asst. Eng.; E. J. Steinbeck, Champaign, Asst. Eng., I. C. R. R.; S. A. Bullard, Springfield City Eng.; W. E. Price, Comargo, Surv. Douglas Co.; A. C. Brancher, Lincoln, Civil Eng.; F. W. Hammett, Comargo, Civil Eng.; J. M. Healey, Champaign, I. C. R. R.; L. N. Sizer, Rantoul, Drainage Eng.; D. L. Brancher, Lincoln, Surv.; O. J. Jones, Cambridge, Surv.; Theo. B. Comstock, Champaign, Prof. of Mining Engineering, U. of Ill.; D. L. T. Bronson, Urbana, Ill.

W. D. P.

The Physical Theory of the Steam Engine and Boiler.

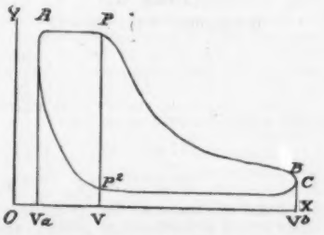
A POPULAR STATEMENT.

Written for ENGINEERING NEWS.

BY ALFRED R. WOLFF, M. E.

(*Concluded from page* 134.)

The first law of thermodynamics is, that heat and mechanical energy are mutually convertible, and that heat requires for its production and produces by its disappearance mechanical energy in the proportion of 772 foot pounds for each British unit of heat.



To represent this graphically, and here we follow Rankine closely, almost verbatim, let the vertical distances measured from the axis $O\,X$ represent pressures, and the horizontal distances from $O\,Y$ represent volumes of an elastic substance, whose alternate contraction and expansion becomes the means of converting heat into mechanical energy. Let $O\,V_a$ and $O\,V_b$ represent respectively the least and greatest volume, which the substance is made to assume, and $O\,V$ any intermediate volume. Let us denote these quantities respectively by V_a, V and V. Then $V_b - V$ represent the space traveled by the piston of an engine, during a single stroke. During the increase of volume from V_a to V_b, the pressure, in order that motive power may be produced, must be greater in the whole than during the diminution of volume from V_b to V_a; so that, for instance, the vertical distance, or distances $V\,P$, and $V\,P_2$, or the symbols P_1 and P_2 may represent respectively the pressures corresponding to a given volume V, during the expansion and contraction of the substance. Then the area $A\,P_1\,B_1\,P_2\,A$ represents the energy exerted by the elastic substance on the piston during a complete stroke, or during a complete cycle of changes of volume of the elastic substance, and its area measures the equivalent of the heat which disappears during a complete forward and return stroke of the piston. That is to say if h_1 represents the quantity of heat in British thermal units received by the elastic substance during one part of the process (such, for example, as the heat communicated to a certain weight of water in the boiler to produce steam, in other words the heat resident in the steam in its initial condition when it enters the cylinder), and if h_2 represents the quantity of heat rejected by the same substance during another part of the process (such, for example, as the heat abstracted from the same quantity of steam by the water of the condenser in a condensing engine, or directly by the air, in a non-condensing engine), and if H and H_1 represent the same quantity of heat in foot pounds (H being equal to 772 h and $H_1 = 772\ h_1$) then $H - H_1 =$ area $A\,P\,B\,P_2$, or using for the area $A\,P\,B\,P_2$, which represents the work done, the symbol W, we have $H - H_1 = W$.

It may be well to specify that the diagram shown represents the actual changes which take place in the engine cylinder. The steam enters the cylinder at one end, fills the clearance space, or the distance between the piston and the end of the cylinder, and drives the piston a given distance $V_a\,V$, steam of original pressure entering the cylinder until that portion of the whole stroke $V_a\,B_1$ measured by $V_a\,V$, is completed. The continual fresh supply of steam during this portion of the stroke is denoted by the fact that the line $A\,P_1$ is horizontal, the pressure at A or V_a and the pressure at P, or V being the same. By the time the piston has traveled a portion of the stroke measured by $V_a\,V$, the admission valve has traveled so that the inlet is closed, and the limited quantity of steam present in the cylinder begins to expand driving the piston ahead, until at the end of the stroke the pressure has fallen to B. Then a connection between the cylinder and the exhaust is opened, and the steam on the return stroke of the piston remains at the low pressure denoted by $P_2\,V$, until the point P_2 of the return stroke is reached. By this time the opening to the exhaust is closed, and the return motion of the piston compresses the steam then present in the cylinder, until at the end of the return stroke its pressure has risen to $V_a\,A$, the original pressure of the fresh steam which now again enters the cylinder for the new forward stroke.

As the first law of thermodynamics, just outlined, enables us to establish the relation between the heat energy expended and the work performed in steam engines, so the second law furnishes us with a simple expression for the limit of efficiency of the steam engine or the greatest conceivable ratio which may exist between the useful work exerted and the heat energy initially in the steam. A comprehensive consideration of the second law of thermodynamics would necessarily make such demands upon intricate mathematical methods of demonstration, as would be foreign to our purpose, and so we will restrict ourselves to its special application to heat engines.

The elasticity and expansion of a permanent gas are measured by the product of the pressure into the volume, $P\,V$, and the temperature corresponding to the disappearance of gaseous elasticity, at which $P\,V = 0$, is known as the absolute zero. This absolute zero, at which either the pressure or the volume of the gas shrinks to nothing, is 459° Fahr. below the ordinary zero of the Fahr. scale. This absolute zero establishes a scale of temperature, which is the basis of all the great laws of gases, and combines them in one expression to the effect that the product of the pressure and volume of any gas is proportioned to the absolute temperature; or expressed mathematically that

$$\frac{P\,V}{P_o\,V_o} = \frac{T}{T_o}.$$

This absolute zero which rests at the foundation of the scale of absolute temperatures is of course a degree of temperature fixed purely by reasoning, no opportunity ever occurring for its observation. The se-

cond law of thermodynamics expressed in terms of absolute temperature reads:—

If the absolute temperature of any uniformly hot substance be divided into any number of equal parts, the effects of these parts in causing work to be performed are equal.

The relation which the work performed in the engine, or rather the energy stored in an engine shaft, bears to the initial heat energy in the steam marks the efficiency of the engine, and since we have seen that the mechanical energy exerted in the cylinder equals the difference between the heat energy in the steam in its initial and final condition, we obtain as the efficiency of a perfect engine, or one in which all the energy exerted in the cylinder demonstrates itself as available power in the engine shaft, the expression $-\frac{H-H_1}{H}$. But since by the second law of thermodynamics the absolute temperature is the measure of the heat, this expression of efficiency of the perfect engine assumes the simple form $\frac{T-T_1}{T}$, in which T is the initial absolute temperature of the steam (or ordinary Fahr. temperature plus 459.4°) and in which T_1 is the final absolute temperature (ordinary temperature plus 459.4°) of the steam as it enters the condenser or the atmosphere.

We have repeatedly used the expression "perfect engine," and have indicated that we meant by this class of engine one in which no loss of friction and the like occurred. As a simple analysis of the efficiency formula $\frac{T-T_1}{T}$ shows, the "perfect" engine, by no means represents a conversion of all the heat energy initially in the steam into mechanical energy. Since T_1 cannot be lower than the temperature of the surrounding atmosphere nor less on an average than say $50+459=509°$ Fahr. and since T cannot in practice exceed $400+459=859°$, the efficiency of any heat engine in its most perfect form cannot exceed

$$\frac{859-509}{859} \text{ or } \frac{350}{859}$$

about 40 per cent., while the efficiency of the perfect steam engine falls much lower, as we shall see, since the temperatures of the expanding fluid of entrance and exhaust do not represent as wide a difference as just stated.

Before analyzing the efficiency of steam engines by the application of the formula $\frac{T-T_1}{T}$, it may be best to state more in detail than has yet been done, what is meant by a "perfect" heat engine, and this brings us to a consideration of Carnot's well known elucidation. Carnot defines as a "perfect" heat engine a reversible engine, or one in which the exact reversal of all the operations performed during the ordinary action of the engine will produce the same cycle of expansions, contractions and heat expenditures in the reverse order. This effect is realized if instead of performing work by the transfer of heat from a hot to a cold body, the expenditure of an amount of energy equivalent to that given out in the direct engine, transfers the same amount of heat from the cold body to the hot body. An engine which can be so reversed works in cycles and has no external losses from radiation, no losses by friction and the like. Carnot was first to point out, and here we follow closely the account given by Maxwell ("Theory of Heat") that if such a reversible engine working between the upper temperature S and the lower temperature T and receiving a quantity H of heat at the upper temperature, produces a quantity W of mechanical work, then no other engine whatever be its construction can produce a greater quantity of work, when supplied with the same amount of heat, and working between the same temperatures. Carnot's principle then is that the efficiency of a reversible engine is the greatest which can be obtained with a given range of temperature. For to state Carnot's argument (we follow Maxwell quite literally), suppose a certain engine M has a greater efficiency between the temperatures S and T than a reversible engine N; then if we connect the two engines, so that M by its direct action drives N in the reverse direction; at each stroke of the compound engine, N will take from the cold body B the heat H, and by the expenditure of work, N gives to the body A the heat H_1. The engine M will receive this heat H_1 and by hypothesis will do more work while transmitting it to B than is required to drive the engine N. Hence at every stroke there will be an excess of useful work done by the combined engine, and since M does more work than N, it converts more heat into work in every stroke, and therefore restores to the cold body a smaller quantity of heat than N takes from it. Hence the legitimate conclusion from the hypothesis is, that the combined engine will, by its unaided action, convert the heat of the cold body B into mechanical work, and that this process may go on till all the heat in the system is converted into work. This is manifestly contrary to experience. As Clausius puts it: "It is impossible for a self-acting machine unaided by any external agency to convey heat from one body to another at a higher temperature," or as Sir William Thomson says: "It is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects."

We are forced to the conclusion, therefore, that no engine can have an efficiency greater than that of a reversible engine (on that account called a "perfect engine"), working between the same range of temperature, and the formula $\frac{T-T_1}{T}$, in which T represents the absolute temperature of the steam, in its initial condition, and T_1 the absolute temperature of the steam in its finnal condition, defines the greatest possible or conceivable efficiency which can be attained. We can now proceed to analyze the efficiency of the "perfect" steam engine on this basis.

Let us first take the case of a non-condensing engine, in which the steam, after expansion in the cylinder, exhausts into the atmosphere at a pressure of say 15 pounds per square inch. Its temperature at exhaust will be 213° Fahr., and assume its initial temperature to be 350° Fahr. (which corresponds to a boiler or gauge pressure of steam of 120 pounds per square inch = absolute pressure of 134.7), the efficiency of the perfect steam engine will be

$$\begin{matrix}350+459=809\\213+459=672\end{matrix}\quad\frac{809-672}{809}=\frac{137}{809}$$

less than 17 per cent. If we take the case of a condensing engine, in which the steam falls to a pressure of say 12 pounds below the atmosphere, when it gives off its heat to the atmosphere by means of the condensing water, then the corresponding final temperature will be 142° Fahr., and the efficiency of the perfect steam engine will equal

$$\begin{pmatrix}142+459=601\\350+459=809\end{pmatrix}\quad\frac{809-601}{809}=\frac{208}{809}$$

not quite 26 per cent.

The case last stated is in a measure ideal since the final pressure does not in practice fall as low as 12 pounds below the atmosphere. We will therefore give an example of the efficiency of a "perfect" steam engine of the marine type, the ranges of pressure and temperature being those attained in the leading marine practice. We adopt as the initial steam pressure 100 pounds per square inch (absolute,) and as the final pressure 5 pounds (absolute) (i. e. ten pounds below atmospheric pressure); the temperatures corresponding to these pressures are respectively 327.63° and 162.5° Fahr., the best theoretical efficiency of such an engine would then be

$$\frac{327.63-162.5}{327.63+459.4}=\frac{165.13}{787.03}=21\ \%.$$

Each pound of steam at 100 pounds pressure contains 1181.9 British heat units, and since 21 per cent. of these would be utilized in the "perfect" marine engine, $1181.9\times.21=248.2$ heat units would be converted into useful work for each pound of steam used. Or remembering that one heat unit equals 772 foot pounds of mechanical energy, $248.2\times772=191{,}610.4$ foot pounds of useful energy would be obtained in the perfect marine engine for each pound of steam used. Since 1,980,000 foot pounds of work per hour equals one H. P., each pound of steam in the perfect marine engine would develop $\frac{191{,}610.4}{1{,}980{,}000}=.097$ H. P. per hour.

We have seen in our boiler calculations that each pound of carbon will in an efficient modern boiler evaporate 11.2 pounds of water, from a temperature of feed of 165° Fahr., into steam of 100 pounds pressure; so for each pound of coal burned per hour, the "perfect" marine engine would develop $.097\times11.2\times\frac{3}{4}=.91$ H. P.; or the development of 1 H. P. per hour would require the combustion of 1.1 pounds of coal per hour. As a fact the best modern marine engines require in regular working about one and three quarter times this amount of fuel per H. P. per hour, showing that less than 60 per cent. of the efficiency of a perfect engine is the actual efficiency of the engine. These practical losses aggregating some 40 per cent. are due to friction, external radiation and conduction of heat, and in great part to condensation of steam in cylinder at entrance and during expansion, and re-evaporation of the condensed water in the cylinder during the process of exhaust. A detailed analysis of these losses would carry us beyond the limits of this paper.

To recapitulate: It has been shown that only some $.21\times.90=19$ per cent. of the heat energy in the fuel can possibly demonstrate itself as available energy in the engine shaft, when the steam engine and the boiler are the heat machines used for the transformation of heat into mechanical energy. We have also seen that, practically, less than six tenths of this possible efficiency is realized at the present day. We may say that the practical limitations of lubricating cylinders, and other determining causes will not, with the present materials of construction, permit the use of initial temperatures in cylinders greatly in excess of 400° Fahr., so that whatever improvements of construction and of the fine working of steam engines may be made in the future, we cannot hope to materially exceed the efficiency of 21 per cent. here determined. The practical objections, such as oxydation of the metal and the like, which are coupled with the use of hot air as the expanding or heat transmitting fluid, besides other consideration of a great first cost, interest and depreciation of plant for the small horse power developed, do not offer a bright outlook for the displacement of the steam by the hot-air engine. And so we can readily appreciate the search after such radical physical developments as the direct conversion of heat into electrical energy and like schemes, which will dispense with heat engines as first motors, and with expanding fluids as the means of converting heat into mechanical energy. But these projects at the present time are merely ideas, and the steam engine, despite its necessary losses, deservedly still occupies the lead, for all except the smallest powers, as the most serviceable, available and commercially speaking-most economical prime-mover.

THE Berlin Iron Bridge Co. has established a branch at Binghamton, N. Y., and has increased its capital from $100,000 to $200,000.

CORRESPONDENCE.

Does Advertising Pay?

CHAMPAIGN, ILL., Feb. 18, 1886.

EDITOR ENGINEERING NEWS:

I find it difficult to get the addresses of Drainage Commissioners, particularly their Post Office. Generally they are not prominent men; men who are not property holders are usually selected because disinterested. The formation of drainage districts is so common that the local papers do not often make mention of them. There is a good deal of that kind of work in contemplation, but it is difficult to get details.

I conscientiously believe that it would be of great financial benefit to interested property holders if the letting of contracts was better advertised. For example, districts have been paying from 15 to 19 CENTS *per yard with often only* ONE BIDDER; *at the Ashkum-Danforth letting, which was advertised in* ENGINEERING NEWS & AMERICAN CONTRACT JOURNAL, *there were* 21 BIDDERS, *scattered from Kansas City to Buffalo (perhaps New York City), and the job was let at the low price of* 10¾ CENTS.

Very truly,
I. O. BAKER.
Prof. Civil Engineering Illinois University.

The drainage letting above referred to was advertised in ENGINEERING NEWS on January 23rd. There were about 357,000 cubic yards of excavation: at 4¾ cents difference between the lowest bid heretofore and 10¾ cents, the SAVING *to the property owners is* $15,172; at 8¾ cents, the difference between 19 and 10¾, *the saving is* $29,452, or over $1,000 per mile of the

ditch advertised. This is the result of a trifling investment in advertising the letting. And it will show better results when more work is advertised.

ENGINEERING NEWS was the first journal in America to bring the possibilities of competition to the attention of property owners, and it very justly is without a rival in its specialty of advertising "Proposals for Lettings" of all kinds of public work. We assert that: *There is no single class journal in the United States read by so many contractors for all kinds of Civil Engineering construction as* ENGINEERING NEWS AND AMERICAN CONTRACT JOURNAL. *We propose as in the past to publish early intelligence of all new contract work. Our price for advertising proposals for contracts is*

TWENTY CENTS PER LINE,

and it is so cheap that parties having any work to advertise will always find it a good investment to use this journal.

EDITOR ENGINEERING NEWS.]

News from the South West.

LITTLE ROCK, ARK., Feb. 19, 1886.

Special Correspondence ENGINEERING NEWS.

On February 2nd, the draw span of the St. Louis and San Francisco R. R. bridge at Van Buren, Arkansas, was connected, and the bridge was ready for the trains in a week thereafter. It consists of one draw-span of 360 feet, three fixed spans of 255 feet each, and four fixed spans of 165 feet each, resting upon ten stone piers, and was built by the Union Bridge Company of New York, at a cost of $500,000; work was commenced April 1, 1885.

At a meeting of the City Council of Little Rock held on the 9th, the contract with the Pulaski Gas Company for lighting the streets of this city for a period of twenty years from this time at the rate of $30 per year for each gas lamp so furnished, and to furnish gas for the city at $2.75 per 1,000 net, and to private consumers $3.25 per 1,000, less 5 per cent. discount if paid within a stipulated time, was ratified. In a minority report opposed to the contract it was shown that the following were the rates paid in several cities in the United States—viz:

	Per lamp per annum.
New York, Jersey City and Burlington, Iowa, lighted every night in the year	$25,00
New Orleans	24,00
Washington	22,00
Dayton, Ohio	21,11
Rochester, N. Y.	18,12
Cleveland, Ohio	17.50
Auburn, N. Y.	17,50

The number of lamps in Little Rock is 254; the difference between $25 and $30 for 20 years is $52,451. The citizens generally favored the minority report.

The grading of the extension of the Iron Mountain railroad from Bald Knob to Memphis was let at Wynn, Ark., on the 11th, and was all gobbled up by Memphis parties. The bridge building goes to New York contractors as previously announced. The following are the names of the successful bidders, and the amount of grading awarded to each: Clements & Kelly, 11 miles; Joseph Flynn, 10 miles: Purcell & Grace, 10 miles: J. C. Hartnett, 23 miles; Jenkins & Yerkle, 18 miles; J. S. Andrews, 5 miles.

Work has been commenced on the new building for the Odd Fellows; it will be a two story brick, and will cost about $14,000.

Fort Smith is to build a $20,000 school house, and the plans, for which several of our architects are competing, will be decided on on the 20th inst.

There has been some dispute between the consolidated sewer districts and district No. 7 with regard to the amount that district No. 7 should pay to the consolidated sewers as their proportion of maintenance, and it has been finally adjusted by an agreement to pay $100 per block, the commission of No. 7 to become members of the board of direction of the consolidated sewers; as this is the first case of the kind, and is likely to become a precedent, an ordnance is to be passed regulating the admission of new sewer districts.

E. R. Moffat, of the Joplin, Mo., lead mines, has ordered the plant for a smelter to be erected in Montgomery county, and will go to work on it as soon as possible. The "Lead King" mine shaft is down 52 feet, and has given assays of $13.50 in silver to the ton. An assay of the ore taken from the hole in the Blackland at Crystal Springs shows $16.40 silver, and 60 % lead at a depth of 50 feet.

Articles of association have been filed in the Secretary of State's office for the Fort Smith and Southern Railway Company. The capital stock is $2,500,000, and the road is to run from a point at or near Fort Smith southwardly through the counties of Sebastian, Logan, Scott, Polk, Howard, Sevier and Little River to a point on the Red river. The length of the road is to be fifty miles. The board of directors consists of Mr. John O'Day, of Springfield, Mo., attorney of the St. Louis and San Francisco railroad; Mr. James Dunn, of St. Louis, chief engineer of the same road; A. Douglass, of St. Louis, also of this road; D. Nichols, of Springfield, Mo., traffic manager of the same line; Jesse Turner, Jr., of Van Buren: Charles Hall, James Brizzolara, B. Baer, W. M. Fishbank, and prominent citizens of Fort Smith.

Col. Fordyce and other officials of the Texas, Arkansas and St. Louis Railway met a delegation of citizens of Lampasas, Texas at Waco on the 13th. The delegation tendered a cash bonus and rights-of-way to the railway company for the extension of the road from its present terminus at Leon to the town of Lampasas. The bonus is variously estimated at from $40,000 to $50,000.

The Paris and Great Northwestern Railroad Company has succeeded in obtaining money necessary to build the road from Paris, Texas, to Red river, and bridge that stream. The engineer corps commenced the work of locating the line on the 17th. It is proposed to strike the river nineteen miles northeast of Paris, where it expects to connect with the 'Frisco line from Fort Smith, Ark. The money has been put up, amounting to $500,000, and the road is to be graded and ironed within the next ninety days. It is generally understood that the 'Frisco company are at the bottom of the movement.

Ohio News.

URBANA, O., February 22, 1886.

Special Correspondence ENGINEERING NEWS.

Articles of incorporation have been filed at Columbus by the Ohio and Kentucky Bridge Company, the object being to erect a bridge over the Ohio river between Cincinnati and Covington.

A quantity of oil taken from the well at Tiffin and sent to Bradford, Pa., to be refined, was pronounced the finest crude in the country, and Bradford capitalists immediately took steps to secure a lease of a large amount of river-flat land in the suburbs of Tiffin, for the purpose of boring for oil.

The coke troubles have greatly reduced freight traffic about Youngstown over all the road. Seven crews have been laid off the N. Y., P. & O. One-third of the freight business has been taken off by non-shipment of ore on the L. S. & M. S. Ry. Freight traffic has been cut 50 per cent. on the Pittsburg, Cleveland and Toledo Road, and the Ashtabula and Pittsburg Road. Business in the town is suffering badly.

Scioto county has sold $31,000 of 6 per cent. bonds to buy toll pikes and make them free. Three companies have accepted the appraisement of their roads.

Belmont county has a bill before the Legislature to authorize the county commissioners to build a pike from Barnesville to the Children's House, and pay for it out of money appropriated to the Bridge fund, not exceeding ten thousand dollars.

Lima has struck a strong vein of oil at about 1,250 feet.

At the bridge letting at Defiance, O., on Tuesday, February 16, there were represented thirteen bridge companies. The bids ran from $11,214 to $24,000, and were fifty-eight in number. There were four bidders on the stone work, and the bids ran from $7.50 to $12.50 per cubic yard. The county commissioners are deliberating. There may be an engineer somewhere around, but nothing is said about him.

The B. and O. having secured the right of way through Pittsburg will, and if possible, this season, construct the missing link from Chicago Junction to Akron, thus making the trunk line complete, saving 40 miles in length, and the equivalent of 100 miles in grades between New York and Chicago. So a writer was informed by a prominent officer of the road, says the Paulding *Democrat*.

The City Council of Delaware have authorized a committee to secure the services of a competent engineer to prepare plans and specifications for a water works system. The speedy construction of such works seems to be almost the unanimous voice. An ordinance granting an electric light franchise was up for the third reading, and was tabled.

The Zanesville and Newcomerstown Railroad Company has been incorporated with capital stock of $25,000. A survey will be made of a route via Adamsville and Otsego to Newcomerstown on the Pan Handle, traversing a very productive valley. The length of the line is about 35 miles.

A bill is now before the State Legislature, to authorize the commissioners of any county to compel convicts under a sentence of imprisonment of two years or less, to work out the time of their imprisonment in the improvement of the public roads, breaking stone, and in the preparation of material for the road, the commissioners to provide guards and food, the Penitentiary to furnish the same kind of clothing used there. A credit of one day's time is to be given on each eight hours of acceptable work.

Butler county commissioners have been superintending stone and bridge work, instead of employing a competent engineer, and recent investigations into the work done and prices paid bring out some striking figures. In a number of cases, bridges costing over one thousand dollars were never advertised. In the case of the masonry the commissioners, in a great number of cases, made the amount from 50 to 150 per cent. more in perches than measurements would make. Walls were laid up with mud or sand without line, and in some cases the walls had to be propped up to make them stand. Next year some other man, probably a farmer, will be in the board of commissioners of every county of the State, and he will be another superintending engi— well, man, of extensive and expensive public works.

By an ordinance which passed the City Council of Columbus on the 22nd, about a mile and a quarter of High street, lying in the main business portion of the city, and which has been paved with asphalt, is to be torn up, and stone blocks substituted. The City Engineer is now drawing plats and plans for the new work. The street has been for a long time in a terribly filthy, dirty and unsatisfactory condition. Much of this state of affairs is due to the continual tearing up of the street to get at water and gas pipe. It seems that it is about time, that in all cities means should be adopted, by which all gas, steam, water and other pipe should be laid in a walled underground square or rectangular tunnel, large enough for the accommodation of all necessary pipes, except sewers, and with manholes properly constructed at intervals, so that, when any trouble was found with any of the pipes, men might enter and do the necessary repairing without destroying a portion of pavement, saying nothing of hindrance of travel.

Illinois and Indiana News.

The Union foundry at Rockford, Ill., was burned to the ground recently. Loss about $3,000.

The plans and specifications have been issued for the new Wabash depot, which will be put up this spring at Effingham, Illinois.

There is some talk of erecting a Masonic temple in Springfield, Ill., and the enterprise will be presented to members of the order and others at an early date.

A stock company is being organized in Bridgeport, Indiana, to build and operate a roller flour mill. The stock has largely been taken in $100 shares, and the prospects of success seem good.

The Danville, Ill., Olney & Ohio River R. R. has been sold for $175,000 to the syndicate of bondholders Austin Corbin represents. There was no rolling stock to sell with the road, it having been operated since C. E. Henderson took the receivership with equipments off of the L., B. & W. R. R.

Gen. Powell, an iron manufacturer of Belleville, Ill., thinks the introduction of the basic process into the iron districts of Alabama and Tennessee will not affect the trade of the North.

The people of Odon, Daviess county, Indiana, who oppose taxation to establish the O. & M. R. R. shops at Washington, are level-headed. The plea that the shops will benefit them is frivolous. The Washington people will have to put more consistent arguments to the people of Odon.

The experimenting for coal at Urbana, Illinois, closed lately, when a depth of 500 feet was reached, at a cost of $1,500. At a depth of 300 feet a thin vein of coal about twelve to fifteen inches thick was struck. When the boring stopped, the drill was in a bed of limestone. This will undoubtedly end the coal prospecting in Urbana for some time to come. The liberal and public-spirited citizens of Urbana have spent $50,000 at various times in experimenting for coal.

At a depth of two hundred and eighty feet gas has been struck in the new well being sunk by Hon. W. C. DePauw, about eighteen miles west of New Albany, Indiana. The flow is the heaviest yet developed in Indiana, but not yet quite sufficient for piping to the city. There is enough of it, however, to run the salt works Mr. DePauw will establish at that point. It is believed, if a depth of 2,500 feet is gone at that point, a sufficiently abundant flow of gas will be struck to justify piping to New Albany.

Articles of incorporation have been issued for the Transcontinental Aerial Navigation Company, of Chicago, to establish aerial transportation lines, the capital stock being $100,000; and the incorporators Arthur Debousette, Eugene Manguret and Jules Long. Debousette has made a study of aeriel navigation for over twenty-two years.

A new line of railroad is proposed from Springfield to Peoria. The surveyor has been over the line getting the right of way. The line will leave Middletown about three miles east, and it is claimed they will commence work in sixty days.

WATER

MONTROSE, COL., is to have artesian wells.

AN artesian well has been sunk in Schuetzen Park, Philadelphia, which supplies 25,000 gallons of water an hour.

THE firm of Grace & Co., of this city, has distributed a prospectus announcing the formation of a company with a capital of $100,000 to light the city of Valparaiso, in the Argentine Republic, by electricity.

THE Widderfield Irrigation Ditch Company, of Las Animas county, Col., has been incorporated, with a capital stock of $30,000, to build two ditches, one on either side of the Apishapa.

J. M. GUFFY & Co. have a corps of engineers at work surveying the site of a line from their Washington county, Pa., gas wells to Pittsburg. As soon as it is located they will lay a ten-inch wrought-iron line.

WICKFORD, R. I., is to decide whether or not it will have water works. Mr. Ingalls, a gentleman from Boston representing the Knowles and Blake Steam Pump Works, of Worcester, has been in the village looking after the matter.

THE Keystone Natural Gas Company of Pittsburg has been incorporated with a capital of $300,000. The company is composed of a number of capitalists, of whom D. A. Stewart, of Carnegie Brothers & Co., is at the head. It is intended to begin work at once to lay a 10-inch wrought-iron main from Murraysville to Pittsburg. The order has been given to the National Tube Works for the pipe, and some of it is ready for delivery. The wells that will furnish the gas have already been developed near Murraysville and are among the very best in that prolific locality. As soon as the pipes are laid gas will be supplied to the Carnegie Works, both at Bessemer and Homestead, and to their extensive works on the Alleghany river front. It is also claimed that a number of the largest manufacturing establishments in Pittsburg are arranging to take gas from the new line.

THE Aqueduct Commission, on February 24th, at the request of Mr. O. B. Potter, decided to extend the hearings on the Quaker Bridge Dam project to April 1st next. They explain that their recent vote to line the entire tunnel with brick at an expense of $1,500,000 "was done in the best interests of the city." Owing to a want of harmony existing for some time between Mr. Craven, Engineer of Construction, and Chief Engineer Church, Mr. Craven has been asked to resign by the Commission. Some time ago Mr. Church asked for Mr. Craven's removal, but the Commission declined to act, and instead assigned Mr. Craven to the duty of consulting with the Corporation Counsel in suits for land damages, etc. The Counsel has declared that he can get all the information he needs from the Chief Engineer, and hence this latest action of the Commission. There seems to be some trouble from the drying up of springs and wells on the line of the aqueduct; but while cases do undoubtedly exist, the damage done so far is rather trivial, and will not cause "the wholesale abandonment of houses, and the damages represented by millions," as stated in some of our daily papers.

WATER SUPPLY OF TACOMA, W. T.—The water is brought from Spanaway lake and Clover creek in a conduit from a point about 10 miles south of the city limits, running by gravitation into the main reservoir which is situated in the southwestern part of the city, on an elevation between the two forks of Gallaher creek, some 260 feet above low tide. Into this reservoir the water pours at the rate of nearly two and one-half million gallons per day, or would so enter were not a very large proportion of the stream carried by the conduit allowed to run to waste down the channel of Gallagher creek into the bay, as the city consumption is yet limited. The reservoir contains 1,700,000 gallons.

From the reservoir the water runs through a twelve-inch pipe for the low service, and is pumped by water power for the high service. The Holly direct-pressure pump is situated in the canyon 185 feet below the level of the reservoir, and 1900 feet distant, and is worked by water from the springs below the reservoir conveyed by wrought-iron pipes to a Leffel turbine with a head of 85 feet. This pump has a capacity of one million gallons in twenty-four hours on the highest levels of the city, 120 feet above the reservoir and 380 feet above the sound. It will maintain three fire streams 80 feet in height from hydrants on the same level. The capacity of the works can be largely increased when necessary by placing in position a second pump which would raise from the creek to the reservoir a supply of 1,500,000 gallons a day. This would give a supply of 4,000,000 gallons a day which would suffice for a population of 60,000 or 70,000. There are now laid down 11.027 miles of cast-iron main pipes of different sizes, from 4 to 12 inches and 1.228 miles of wrought-iron pipes, a total of 12.255 miles.

No. 8. Water Pressure in Mains of Various Cities.

COMPILED BY J. J. R. CROES. FROM SPECIAL RETURNS, DEC., 1885.

TOWN AND STATE.	Topography.	Difference of level in town.	In Business District.		Fire Pressure.
			Day Pressure.	Night Pressure.	
		feet.	lbs.	lbs.	lbs.
Fryeburg, Me.	nearly level.	0	58	60	58 to 60
Gainesville, Tex.	level.	0	60	60	110 to 120
Gardiner, Me.	hilly.	90 to 115	——	——	——
Gardner, Mass.	hilly.	100 to 150	——	80	to 125
Georgetown, Col.	level.	20 to 30	50 to 65	——	120
Geneseo, Ill.	level.	0	20	20	90
Geneva, N. Y.	hilly.	50	85	90	85 to 90
Gettysburg, Pa.	hilly.	10	50	50	50
Glens Falls, N. Y.	sloping.	——	90	90 to 200	90 to 200
Glenwood, Minn.	nearly level.	20	60	70	60 to 70
Gloucester City, N. J.	level.	0	40 to 45	45	45 to 150
Gloversville, N. Y.	hilly.	80	110	110	——
Gorham, N. H.	level.	25	36	36	56
Goshen, Ind.	level.	10	40	30	80 to 100
Goshen, N. Y.	hilly.	50 to 75	55	60	55 to 60
Gouverneur, N. Y.	uneven.	25	30	30	35 to 60
Grand Haven, Mich.	level.	40	40	40	90
Grand Rapids, Mich.	level.	100	50 to 60	——	——
Greenfield, Mass.	rolling.	60	95	95 to 100	95
Greenville, Ill.	hilly.	70	80	60 to 75	175 to 200
Greenwich, Conn.	hilly.	——	65	65	65
Hackettstown, N. J.	hilly.	40 to 50	40	40	40
Halifax, N. S.	hilly.	100 to 200	40	40	60 to 75
Hamilton, Ohio.	——	35	95	95	95 to 160
Hamilton, Ont.	sloping.	70 to 010	60	——	75

THE following places are to have water works:—Bœnville, N. Y., Delhi, N. Y., Ellsworth, Me., Shoshone, Idaho, and Raleigh, N. C.

SUITS for damages aggregating $23,500 have been begun against the city of Brooklyn by residents of the "flooded districts," for losses sustained by the overflow of sewers. An attempt is being made to compromise these suits, on condition that the city repairs the sewers and repaves the streets.

BORINGS have been made below the dam in Milwaukee river by the city engineer of Milwaukee recently, without satisfactory results. The bottom of the river in the locality where it is proposed to construct the new $50,000 dam, seems to be covered with a layer of gravel from 20 to 30 feet in thickness. The city engineer has bored to a depth of 18 feet without striking rock bottom.

THE city engineer of St. Paul, Minn., has completed the plans, maps and diagrams of the Maria street sewer system, otherwise known as the Dayton's Bluff sewer. The estimated cost of the complete system of sewers for the Fifth ward is $50,000. Proposals have been invited and the work advertised, and the bids will probably be opened and passed upon within two weeks.

MESSRS. House and Kierstead, Engineers of Omaha are now preparing plans for the Columbus city water works. They are to cost about $25,000, and to consist of a standpipe 100 feet high supported by 50 feet of brick work. Pumphouse to be of brick 30 feet × 35 feet, and to use about 18,000 feet of water mains, of 10, 8, 6 and 4 inch pipe. Engines to have a capacity of pumping 850,000 gallons in 24 hours.

THE old Cornish pump at City Mill pumping station, Wilmington, Del., has been sold to Joseph Rosenthal & Co., of Philadelphia, who paid $150 and remove it at their own expense. The pump was constructed about 1854, by the firm of Pusey & Jones of Wilmington, but has not been operated since the Worthington pump was put up in 1872. Its removal is necessary in order to make room for the new pump now being constructed.

THE San Diego, California, Water Works Company has contracted with the Holly Manufacturing Company, of Lockport, N. Y., for a Gaskill compound condensing pumping engine of two millions daily capacity, which is to pump water alternately into two distributing reservoirs at elevations of 145 and 300 feet respectively, forming a high and low service. The engine is guaranteed when pumping into the lower reservoir, to show a duty of 85,000,000 foot pounds, and when pumping into the high service reservoir, a duty of 70,000,000 foot pounds per 100 pounds of coal.

THE Philadelphia Water Committee has recently relieved the sub-committee from further consideration of the communication of the South Mountain Water Company, on motion of Mr. Bardsley, and decided that it should be considered in committee of the whole at a special meeting.

AT a meeting of the City Council of Pekin, Ill., on the 17th, Alderman Herget offered a resolution in effect that the fire and water committee be authorized to receive propositions from various companies, for building water works, and to report at the next regular meeting what had been done, which resolution was adopted with only one vote opposed. It was also resolved by a majority vote that the Council visit two or more water works in other cities. The aldermen are Messrs. Behrens, Boley, Erxleben, Herget, Michael, Schipper, Schnellbacher, Schurman and Sutton. Schurman seems to be the most opposed to water.

A GOOD flow of water has been struck on Mr. John D. Morrissey's ranch, some 8 miles up the Platte river, Col., at a depth of 800 feet. It is estimated that the present flow will amount to 60,000 gallons per day. Work on this well was begun about six weeks ago by Mr. A. P. Switzer of Littleton, who has sunk several wells at Littleton and Petersburg. In going through the shale two miner flows were struck, but they were strongly impregnated with arsenic, and they acted as an emetic when drank. The third flow is pure and wholesome. The well has been cased, and the water now flows through pipes wherever it is needed on the ranch. There was no means of ascertaining the amount of pressure with exactness, but a weight of 200 pounds failed to check the flow from a 3-inch pipe 30 feet above the well.

THE water works for Paducah, Ky., built by Messrs. Bullock & Mercer, and designed by E. F. Fuller, C. E., all of New York, were satisfactorily tested on February 15th. On the evening of the same day the works were accepted by the City Council, and a vote of thanks tendered to the water company, engineer and contractors. The two engines are built by the Holly Manufacturing Company of Lockport, N. Y. These engines are guaranteed to be capable of pumping 2,000,000 gallons each in 24 hours against 222 feet head, and develope a duty of 85,000,000 pounds per 100 pounds of coal consumed. The stand-pipe is 22 feet in diameter and 175 feet high; the fire-hydrants are from Pattee & Draper, of Holyoke, and the valves from the Peet Valve Company. The company owning the works is known as the Paducah Water Supply Company, and has an exclusive franchise for 40 years.

THE people of the village of Jamaica are to vote on the question of introducing water, the cost of which is variously estimated at from $50,000 to $100,000. Nearly all the leading citizens are in favor of having a water supply. A company which makes a business of providing villages with water has submitted a proposition which the intelligent men are opposing, and it stands no chance of being adopted. Everybody favors having the works built by the village.

THE Cambridge, N. Y., Water Works Company has contracted with Adam Miller & Co., of Rome, N. Y., to construct a system of water works for that village. The works to consist of two reservoirs of over 2,000,000 gallons each, one located at Simpson's Springs, about two and a half miles northeast of the village, another on "Bowen" hill, about two and a quarter miles distant and about a quarter of a mile from Simpson's Springs. The reservoir at the springs will furnish the power to run a wheel and duplicate pumps, capable of pumping from 40,000 to 60,000 gallons per day into the "Billings" reservoir, on Bowen hill, which is 220 feet above the springs and 165 feet above the highest, and 200 feet above the lowest point in the village, the water from the springs will be pumped directly through the mains to the village, a check valve holding the water in the Billings reservoir in reserve until such times as more water is required than the pumps can furnish, which would probably be in case of fire only. The works complete will cost from $35,000 to $40,000. A large force of men will be employed as soon as the frost is out of the ground, and it is expected to have the works completed by the 1st of the 15th of July next. The works will require about 600 gross tons of iron pipe.

NEWS OF THE WEEK.

CONTRACTING.

Coal Contract.—The whole Grand Trunk R. R., coal contract of 400,000 tons, to be delivered at the Niagara bridges, has been awarded to Bell, Lewis & Yates, of Buffalo. This is a great surprise to the soft coal men there, as heretofore they have annually been invited to Montreal to hand in their bids. The price at which the contract was awarded is not known.

Railway Company vs. Contractor.—MONTREAL, Feb. 23.—The case of contractor McRae against the Canadian Pacific Railroad was settled this afternoon by the company's paying the contractor $121,000, and agreeing to pay the crown dues, amounting to $10,000.

Paving Blocks and Curbs.—Bids will be received at the office of the Superintendent of Streets, Charleston, S. C., until March 1, for 276,000 granite paving blocks, 9 to 15 inches long, 3½ to 5 inches wide and 7 inches deep. The average size must measure 51 square inches on the top, thus making 25½ blocks to cover one square yard when laid. Faces and edges cut square Also for 15,000 linear feet of 14-inch blue stone curb, not less than 3½ inches thick, face to be dressed six inches deep.

Contracts for the Graduation, Trestling, Piling and Cross-Ties for that part of the Memphis, Birmingham & Atlantic Railroad, lying between the Illinois Central Railroad, at Holly Springs, and the Mobile & Ohio Railroad, at Tupelo, about 60 miles, have been awarded as follows:

GRADUATION.

Sections 1 to 8, inclusive, to Wright & Co., Richmond, Virginia.

Sections 9 to 11, inclusive, to E. Q. Withers & Co.' Memphis, Tenn.

Sections 12 to 19, inclusive, to A. Bodkin, Yazoo City, Miss.

Sections 20 to 26, inclusive, to A. & C. Wright, Shelby, N. C.

Sections 27 to 35, inclusive, to E. Q. Withers & Co., Memphis, Tenn.

Sections 36 to 39, inclusive, to E. Woodard, New Orleans, La.

Sections 40 to 50, inclusive, to J. J. Cooney & Co., Memphis, Tenn.

Sections 51 to 61, inclusive, to J. S. Montgomery, Starkville, Miss.

TRESTLING AND PILING.

Sections 1 to 33, inclusive, to T. L. & C. J. Houser, St. Louis, Mo.

Sections 34 to 61, inclusive, to R. DeT. Lawrence, Marietta, Ga.

CROSS-TIES.

For the entire distance, 60 miles, to D. H. Pitts & Co., Scottsville, Va.

R. H. TEMPLE,
Chief Engineer, Memphis, Tenn.

The Colorado Capitol Contract.—Considerable interest was excited yesterday over the opening of the bids for the erection of the capitol building. At 12 o'clock, noon, the time fixed for the opening of the bids, there were present in the rooms of the governor the members of the commission and those who had put in bids for the contract. George T. Clark, secretary of the commission, read the bids of those who competed for the prize.

The bids as read were as follows:

Peter Gumry, of Denver, $1,294,476.

Hennessey Brothers, Agnew & Cox; of St. Paul, Chicago and Denver, $1,067,795.

J. S. Moreasse, of Detroit, Mich., $1,227,068.

E. F. Hallack Manufacturing Company, of Denver, $1,274,539.

W. D. Richardson, of Springfield, Ill., $990,252.

Rocky Mt. *News*, Denver, Feb 21, 1886.

Railroads and Canals.

A Northwestern Line.—A new line of road is in contemplation, extending from Abbotsford, on the Wisconsin Central, to Merrill, on the Milwaukee and St. Paul, a distance of about forty miles.

The St. Louis, Des Moines and Northern Railroad has definitely decided to extend its line north from Boone, Iowa, to St. Paul. The section from Boone to Mason City will be built this year.

A Tunnel Caves in.—CHATTANOOGA, TENN., February 19.—The King's Mountain Tunnel on the Cincinnati Southern R. R. caved in Thursday night, and was impassable to trains yesterday. All passengers were transferred.

Detroit's New Bridge.—Gen. Poe, of the engineer corps, has reported favorably on the house bill to bridge Detroit river at Belle Isle, so as to form an approach to the city's island park. Gen. Poe sees no obstruction to navigation in the construction of the bridge, which will cost $300,000.

Helena & Great Falls R. R.—A contract for the construction of forty miles of this road has already been awarded, and work has been commenced. The road will tap the Northern Pacific R. R., at Helena, and connect this line with the Great Falls of the Missouri above Fort Benton.

Another Long Island Project.—The Cedarhurst Association, which contemplates building a railroad from East New York to Far Rockaway and Cedarhurst, has purchased several farms at New Lots. The railroad company intends to turn them into villages and connect them with the elevated railroad at East New York.

Minnesota Extensions.—For some time past the Minneapolis and St. Louis Railroad Company, in conjunction with the Northern Pacific Railroad Company, has been acquiring and now has almost obtained right of way from Minneapolis to Anoka. The Minneapolis and St. Louis R. R. has a corps of surveyors, locating a route from Anoka to Duluth, and as soon as the spring opens, construction work will at once be prosecuted with vigor.

The Chicago and Central Iowa Railway Company, with principal offices at Chicago, has been incorporated to construct a line of railroad from the town of Lacon, on the Illinois river, to Keithsburg, on the Mississippi. Capital stock $1,600,000. The incorporators and first board of directors are Frank L. Underwood, of Kansas City; Luther H. Pierce and Andrew Crawford, of Lakeview, Ill., and James Walsh, Horace Williston and Arthur L. Sullivan, of Chicago.

Nebraska Projects.—Nebraska will come in for its share of railroad building during the present year, as the appended summary will evidence. Only work definitely decided upon has been included:

BURLINGTON AND MISSOURI RIVER R. R.

	Miles.
Grand Island to Broken Bow	100
Tobias to Blue Hill	61
Edgar to Superior	26
Elwood Northwest	43
Hastings to Aurora	26
Omaha to Ashland	26
Fairmont South	15
Total	296

CHICAGO AND NORTHWESTERN R. R.

Chadron to Fort Fetterman	100
Black Hills extension	50
Scribner to Humphrey	45
Fremont to Lincoln	50
Total	245

MISSOURI PACIFIC R. R.

Weeping Water to Lincoln	30
Papillion to Omaha	6
Total	36

The grand total assured is 878 miles, with a number of other projects under consideration.

A $10,000 Iron Bridge.—Mr. Gordon's bill for the appropriation of $10,000 for the erection of an iron bridge over the Erie canal at Main street in Lockport has been passed.

The Gulf, Colorado and Sante Fe R. R. contemplates completing the work to Farmersville from Dallas in ninety days. The preliminary surveying party is on the other side of White Rock creek having been kept there several days in running four or five lines. The topographical survey is two miles behind the first party, and the cross-sectioning corps is two miles and a half from Dallas. The right of way agents are getting along.

Another London Underground.—A company has been formed to construct an underground railway from King William street, in the City of London, under the river Thames, to the Elephant and Castle, Newington Butts. There will be two separate tunnels for the traffic; and the time between termini is put at about nine minutes; it will be worked on the cable system. The capital is £300,000.

Big Fight between Bridge Companies.—Messrs. Iglehart & Taylor, of Evansville, Indiana, and H. A. Gardner, of Chicago, attorneys for the Keystone Bridge Company of Pittsburg, have brought suit in the United States Court, against the Henderson Bridge Company for balance due them for materials and labor on the bridge at Henderson, Kentucky, claiming a balance of $100,000. The plaintiffs, in addition to the above amount, claim $40,000 caused by the delays of the Henderson Bridge Company by failing to do its part of the work in time, in approving plans, building piers, etc. The amount unpaid on the building contract, as shown by the final estimates of the engineers of the Henderson Bridge Company, is claimed to be $79,000. Cincinnati *Enquirer*.

The Hennepin Canal.—WASHINGTON, Feb. 17.—Mr. Murphy, by direction of the committee, to-day reported favorably the bill for the construction of the Hennepin canal, and it will be placed on the calendar of the committe of the whole. The bill reported is that introduced by Gen. Henderson, and provides for accepting the offer made by the State of Illinois and the Illinois and Michigan canal for the construction of the work contemplated from Hennepin to the mouth of the Rock river. The main canal would be about seventy-five miles long, and the feeder to Dixon thirty-seven. The report of the committee presents a comprehensive explanation of the enterprise, showing that it is in no sense local, and that its construction will confer great benefits on all sections of the country at large. As it is held to be national in character, it would be authorized by Congress. The cost of the work is estimated at $9,000,000, of which $6,673,000 is for construction of canal and feeders, and $2,298,000 for the enlargement of the Illinois and Michigan canal.

A Railroad of Bridges.—On the Auburn division of Chief Engineer P. F. Brendlinger's Penns. Schuylkill Valley R. R., in a distance of a trifle over two miles, there is the remarkable number of six iron bridges. The first bridge of the series is just below Auburn, and is said to be the finest bridge on the P. S. V. R. R. This bridge is built on a compound curve and is over 700 feet in length, consisting of two deck truss and two through truss spans, the whole bridging the Schuylkill river, the P. & R. R. R. and the P. & R. canal. This bridge contains nearly 3,000 cubic yards of first class masonry and over 500 tons of iron.

The next bridge crosses Pine creek, at its entrance into the Schuylkill river. This bridge consists of three through spans and is also built on a curve and on a skew, that is the masonry is built at a lesser angle than a right angle to the line of the railroad.

We then pass the Trout Run bridge and come to the large bridge crossing the Schuylkill river and canal. This bridge which is only second to the Auburn bridge consists of two through truss spans, being 320 feet in length and also built on a great skew. Owing to the size of pier and depth of water, a crib and caisson was first sunk and the masonry was commenced on the crib. The masonry of this, as well as that of all the other bridges, is what is termed first class. Going ahead a few feet more, the road again crosses the Schuylkill river on a curve. This bridge consists of two deck spans, and here too the artistic is combined with the substantial. Next we come to the canal cut bridge spanning the "canal cut" as its name indicates. This fine bridge consists one through truss span of 103 feet and is built on a heavy 84° curve and on a great skew. The greatest difficulty was encountered on all these bridges, in laying the foundations, owing to the treacherous material composing the beds of the rivers, the material being mostly mud or silt. The total cost of these bridges will be in the neighborhood of a quarter of a million of dollars. The Auburn division is in charge of Engineer Theodore Low, ably assisted by O. B. Magruder, Franklin Duane and John Shuster.—Miner's *Journal*, 22d.

Market Report of Engineering Materials.

New York, February 25, 1886.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.			
Angles		2.00c	@ 2.10c
" steel		2.35	@ 2.45
Tees		2.35	@ 2.40
Beams and channels, American		3.0	@
Tank Plates		2.0	@ 2.1
Shell Plates		2.4	@ 2.5
Steel plates, Tank		2.5	@
WROUGHT-IRON PIPE.. PITTSBURGH.			
Butt welded, black	Discount	42½	@ 45
" " galvanized	"	32½	@ 35
Lap welded black	"	60	@ 62½
" galvanized	"	42½	@ 45
Boiler tubes	"	55	
RAILS.			
Steel (large lots at mill)		$34.00	@ $34.50
Old rails		22.00	@ 22.25
Old rails, steel		22.00	@ 23.00
R R. spikes		2.40c.	
R R. splice-plates		2.00	
R R. track bolts, square nuts		3.00	
Barb-wire fencing, galvanized			5.00
" painted		4.00	
Corrugated iron			
Nails			
Iron, per keg		2.40	@ 2.50
Steel do.		2.60	@ 27.5

METALS.

COPPER.			
Lake Superior		$11.40	@ 11.50
Other Brands		10.25	@ 10.45
LEAD.			
Com. Domestic		4.65	4.70
Lead Pipe		.06¼c.	
Tin-Lined Lead Pipe		.15	
Sheet Lead		.07¼	
ZINC.			
Sheet		$5.10	@ 5.20

BRICK.

Cargoes (afloat)			
Haverstraw	per M.		
Fishkill			
Up-River			
Jerseys		7.00	@ 7.50
Long Island		8.00	
Pale		4.50	
FRONTS.			
Croton, red		11.00	@ 14.00
" dark		11.00	@ 14.00
" brown		10.00	@ 13.00
Philadelphia pressed		24.00	@ 25.00
Trenton "		24.00	@ 25.00
Baltimore "		37.00	@ 41.00
Buff "		33.00	@ 35.00
Enameled English		65.00	@ 130.00
" American		85.00	@ 120.00
Fire brick		24.50	@ 55.00

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

Alsen's Portland Cement Works	$2.50	@ $3.00
BAETJER & MEYERSTEIN:		
Hanover Portland	2.60	@ 2.65
BELLONI & CO.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
K. B. & S.	2.55	@ 3.00
BROOKS, SHOOBRIDGE & CO.	2.45	@ 2.60
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.65	@ 2.90
K. B. & S. " "	2.75	@ 2.95
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fieve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	$2.40	@ 2.75
GABRIEL & SCHALL:		
Vorwohler "Lion"	2.65	@ 3.10
HUDSON RIVER CEMENT CO. Rosendale		1. 0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.40
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
MARCIAL & CO.:		
J. B. White & Bros. Coarse	4.50	@ 5.00
" Fine	8.00	@ 10.00
" Portland	2.45	@ 2.85
NEW YORK CEMENT CO.:		
Rosendale		1.20
N. Y. & ROSENDALE CEMENT CO.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BABSON:		
K. B. & S.	2.35	@ 2.60
STANDARD CEMENT CO.		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT CO.:		
Windsor	1.00	@ 1.10
Standard		1.15
Cable Portland	2.15	@ 2.40
UNION AKRON CEMENT CO.:		
Akron "Star" brand		

ASPHALT.

Prices range per ton		$15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.			

LIME.

Rockland, common per bbl		1.00	
" finishing		1.20	
State, common		.90	
" finishing		1.10	
Kingston, ground		95	@ 1.00
Add 25c. to above figures for yard rates.			

STONE.

Cargo rates at New York.

Amherst freestone, No. 1	per cub. ft.	0.95	@ 1.00
" " No. 2	"	0.75	@ 0.85
" " light drab	"	0.80	@ 0.95
Berlin " in rough	"	0.75	@ 1.00
Berea " "	"		
Brown stone, Portland, Ct.		1.00	@ 1.35
" Belleville, N. J.		1.00	@ 1.35
Granite, rough		0.45	@ 1.25
Common building stone per load		2.00	@ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.		0.40	@ 3.00

SLATE.

Purple roofing	per square	6.00	@ 7.00
Green	"	6.00	@ 7.00
Red	"	15.00	
Black Penna. (at New York)	"	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box	per M.	18.00	@ 20.00
" Choice	"	65.00	@ 70.00
Tally plank, 1¼ in. 10 in. dres'd, each		.44	@ .50
Tally boards, dressed com.	"	.28	@ .30
SPRUCE, Boards dressed	"	.25	@ .28
Plank, 1¼ in	"	.28	@ .30
" 2 in.	"	.38	@ .40
" 2 in. dressed	"	.43	@ .45
Timber	per M.	20.00	@ 22.00
HEMLOCK, Boards	each.	.18	@ .20
Joist, 2½ × 4 to 4 × 6 in		.16	@ .44
OAK	per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2½ in	"	35.00	@ 40.00
YELLOW PINE, Girders	"	25.00	@ 30.00
Dressed flooring	"	28.00	@ 35.00
SHINGLES, Extra shaved pine, 16in.	"		
" sawed 18 in.	"	5.75	@ 6.00
LATH, Cargo rate	"	2.30	@ 2.35

PAINT.

Lead, white, American dry	per lb	.04½	@ .06
" " in oil pure	"	.06½	
" English, B. B. in oil	"	.08¾	@ .08¾
" Red, American	"	.05¾	@ .06¾
Litharge	"	.05	@ 05½
Venetian red, American	"	.01	@ .01¾
Indian red	"	.05	@ .10
Vermillion, American lead	"	.10½	@ .12¼
Paris green	"	.15	@ .20
Umber, Amer. raw and powdered	per lb.	.01¾	@ .01¾
Drop black, Amer.	"	.07	@ .13
" Eng.	"	.11	@ .13
Chrome green	"	.05	@ 20
Oxide zinc, American	"	.03¾	@ .04
" French	"	.06	@ .08

Trade Notes.

THE Savannah, Dublin & Western Railroad Company is negotiating for 22,000 tons of steel rails.

THE Ashland Furnace in Maryland is now turning out Bessemer iron.

THE new steel plant in Pottsville, Pa., has been completed, and operations will be started shortly.

Cherry, Morrow & Co., of Nashville, Tenn., have contracted with the National Tubular Axle Co., Chicago, Ill., for 2,000 sets of that firm's tubular axles.

THERE is talk of an iron foundry being started at Cartersville, Ga.

THE Columbia Iron Co., with a capital of $50,000, has been chartered at the State Department, Harrisburg, Pa.

THE Woodward Iron Co., Wheeling, Ala., is having a blast furnace hoist built by the Webster, Camp & Lane Machine Co., of Akron, Ohio.

THE rolling department of the Jefferson Iron Works, Steubenville, O., was started on the 8th inst. with between thirty and forty men at work, for the purpose of working up a lot of pig-iron remaining in stock.

THE Phœnix Iron Works, at Meadville, Pa., are adding a larger iron and steel plate-planer and a heavy power roller for rolling the plates into proper shape for boilers to the establishment. The two machines weigh 40,000 pounds.

THE iron and steel makers are looking for a heavy demand in March to carry them into early summer at prices now prevailing, viz.: $16 to $17 for forge iron at tide water, $2.40 to $2.60 for nails, $34.50 to $35 for steel rails, and bar iron $1.50 to $1.75.

THE Cambria Iron Co., of Johnstown, Pa., will increase their works at Birmingham in the spring and give employment to several hundred more hands. At Birmingham are located the extensive limestone quarries of the company, which supply the furnaces.

ERIE, Pa., Feb. 15.—The strike in the coke regions is having a serious effect upon the iron interests here. In the first place it has stopped the shipments of iron ore from Erie, and the 80,000 tons of ore which yet remain in the docks, and which it is expected would have been shipped by the opening of navigation, will probably remain here for some time.

THE Brooks Locomotive Works are constructing eight-wheeled passenger engines of the following dimensions for the Bee Line: cylinders, 18 x 24 inches; driving wheels, 62 inches; steel-tired truck-wheels, 30 inches; and 33-inch tender wheels; the boiler has 195 2-inch tubes; the tank is of 3,000 gallons capacity; engines to be equipped with Westinghouse automatic air and driver brakes. Total weight of engine, about 83,000 pounds.

WE give below an official statement of the number of barrels of cement produced in this (Somerset) county during the years 1883-'84-'85:

	1883	1884	1885
F. O. Norton, High Falls	30 131	13 396	9 825
T. R. Keator & Co.	89 200	60 800	73 000
J. H. Vandermark	47,400	43,338	42 000
Lawrenceville Co.	106 500	89 793	91 195
Rosendale Co.	43 000	33 200	54 268
N. Y. and Rosendale Co.	168 000	144 352	153 946
New York Co.	78 000	138 236	147 201
R'k L'k and Rosendale Co.	121,686	104 099	219 01
Connelly & Shaffer	115 300	112 000	1.0 240
F. O. Norton, Binnewater	182 384	164 000	157 747
Newark and Rosendale Co.	167,000	140,000	168 000
Newark Lime and Cement Co.	244,555	193 000	256,000
Hudson River Co.	117,660	141,000	132 000
James Co.	70,000	57 000	59 980
Lawrence Co.	184,200	168 0 0	152,000
Kingston Co.	70 000	49 200	.. ..
Total	1798,628	1651,411	1748 622

The Newark Lime and Cement Company stopped grinding on the 15th of January. They have stored seventeen or eighteen thousand barrels, which is considerable less than the usual quantity stored in the winter.—Kingston (N. Y.) Argus.

Messrs. H. K. Porter & Co., Pittsburg, builders of light locomotives, have orders for over a dozen engines. One has just been complete for the Homestead Steel Mill, and another for the Mexican Guadalupe Silver Mining Co. One has been shipped to the Seneca Falls and Waterloo Street Railroad Co. Six have been shipped o the Isthmus of Panama Canal Railroad Co. Among those that are being made for a distance is one for Japan.

A TEST OF BOILER STEEL.

THE following test by drifting is adopted by Mr. Henry Schlacks, superintendent of motive-power of the Illinois Central Railroad. A ⅞ inch hole is drilled in one corner of a piece, ⅝ inch from each side, and then drifted out. If the hole can be enlarged to 1½ inches when the crack has just opened from the side to the hole it is good material. A ⅝-inch hole in the center of a piece 3½ inches wide should drift out to 2½ inches to 2¾ inches when the crack runs from the side to the hole. In the drifting test everything depends on the drifts and the weight of sledge. The smaller or first drift should be not less than 12 inches long, ⅝ inch at small end and 1 inch at large end, and finished on a lathe. The second drift should be 16 inches long, ⅞ inch at small end and 1½ inches at large end, while the third drift may be 18 inches long, and 1½ inches at small end and 2¾ inches at large end. A hammer not heavier than 4 pounds should be used, and the drifts should be oiled and driven from both sides, with not over four or five blows on either side at a time. If the drifts be short and blunt and the hammer 16 or 18 pounds, the enlargement of the hole at each blow is so instantaneous that the strain exceeds the strength of the steel, and even copper, under these circumstances, may be broken before it has drifted 1-16 inch. With light hammer and drifts, as described, a very satisfactory understanding, in a rough way, may be had of the ductility of steel.

THE NATIONAL FOUNDRY SCHEME.

WASHINGTON, D. C., Feb. 8.—Senator Hawley, chairman of the Select Committee of the Senate on Ordnance and War Ships, today submitted the committee's report. It gives an exhaustive account of the examinations by the committee of the principal works and yards in this country and England and of the information gained from other sources, and as a result gives the following conclusions:—

First—The United States is metallurgically independent for all purposes of warfare.

Second—The manufacture of iron and steel for peaceful purposes has kept pace with the foremost science and skill of the world. For steel-making the casting capacity is ample but the heavy forging and finishing of guns and armor will require new and costly plant.

Third—The machinery and machine-tools of the Navy-yard are sufficient for the building of engines, but much of it is obsolete and no longer economical; the means of building iron or steel ships are lacking; one yard has a good plant of limited capacity for furnishing steel guns, and has done some good work.

Fourth—As a partial relief upon private builders, and as a resource in case of necessity, some ships should be built in navy-yards, the parts to be furnished by private foundries. Ships in general should be built by private contract, and private yards are capable of doing the work. The uncertain nature of repairs is such that some Government yards should be kept ready to make them.

Fifth—Armor plate and engines should be obtained wholly from private manufacturers.

Sixth—The costly experiments of twenty-five years have reached a stage which justifies certain conclusions. Guns should be made of open-hearth steel, forged, breech-loading, chambered, of calibres ranging from 5 to 16 inches, often ranging from 30 to 35 calibres. Armor and projectiles should be made of forged steel. The hydraulic forging-press produces better results than the steam hammer, costs much less, and should be used for Government work. Ships should be constructed of steel, but certain minor classes may be composite of steel and wood.

Seventh.—The manufacture of guns suitable for ships and coast defence should be divided between private foundries and Government shops; the former providing the forge and tempered parts, and the latter finishing those parts and assembling them.

Eighth—The Government should establish two factories for machine-finishing and assembling guns. The weight of opinion among army and navy experts and prominent manufacturers of heavy work in steel decidedly indicates the Washington Navy-yard and the Watervliet Arsenal as the best sites for such factories. When the determination to contract for heavy guns shall have been reached, the localities for finishing can be determined easily.

Ninth—All needed private capital is ready for cheerful co-operation with the Government in whatever it may require.

Tenth—Proposals for armor and guns should require such quantities and extend over such a series of years, as to justify private persons in securing the best plant.

Payments should be made only for completed work, and only the guaranteed bids of persons having capital and experience should be considered.